AD-A064 781 DIGITAL PROGRAMMING SERVICES INC WALTHAM MASS F/G 4/2
DEVELOPMENT AND APPLICATION OF MATHEMATICAL PROCEDURES TO A VAR--ETC(U)
JUN 78 L E BELSKY, M W FRANCIS, F B KAPLAN F19628-76-C-0241
UNCLASSIFIED AFGL-TR-78-0170 NL

1 OF 3
AD
A064781

AFGL-TR-78-0170

LEVEL II

AD A064781

DEVELOPMENT AND APPLICATION OF MATHEMATICAL PROCEDURES TO A VARIETY OF CLOUD PHYSICS RESEARCH DATA

Lawrence E. Belsky
Michael W. Francis
Fredric B. Kaplan
Daniel Leach
Keith Roberts

Digital Programming Services, Inc.
60 Hickory Drive
Waltham, MA 02154

30 July 1978

Final Report for period
1 July 1976 - 30 April 1978

Approved for public release; distribution unlimited.

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

(19) REPORT DOCUMENTATION PAGE

(18) 1. REPORT NUMBER: AFGL-TR-78-0170	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER (9)
(6) 4. TITLE (and Subtitle): DEVELOPMENT AND APPLICATION OF MATHEMATICAL PROCEDURES TO A VARIETY OF CLOUD PHYSICS RESEARCH DATA.	5. TYPE OF REPORT & PERIOD COVERED: FINAL ≠ Rept. 1 JUL 76 to 30 APR 78 / 6. PERFORMING ORG. REPORT NUMBER
(10) 7. AUTHOR(s): Lawrence E. Belsky, Michael W. Francis, Fredric B. Kaplan, Daniel Leach, Keith Roberts	(15) 8. CONTRACT OR GRANT NUMBER(s): F19628-76-C-0241
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Digital Programming Services, Inc. 60 Hickory Drive Waltham, MA 02154	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 63311F (16) 627A00BG (17) 00
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Geophysics Laboratory Hanscom AFB, Bedford, MA 01731 Contract Monitor: Morton Glass/LYC	12. REPORT DATE: (11) 30 JUN 78 / 13. NUMBER OF PAGES: 273
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office): (12) 274 p.	15. SECURITY CLASS. (of this report): Unclassified / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Airborne data collection, cloud physics, data processing, real time operating system, software documentation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report summarizes the mathematical procedures used on a variety of standard and non-standard cloud physics data. It includes the complete descriptions and operating instructions for all programs developed under this contract.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

388543

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

79 02 09 027

CONTENTS

APPENDICES

FIGURES

1. Introduction

During the period of April 1976 through April 1978 DPSI was under contract (F19628-76-C-0241) to the Convective Cloud Physics Branch (LYC), Meteorology Division of the Air Force Geophysics Laboratory (AFGL). The purpose of this contract was to develop and apply mathematical procedures to a variety of standard and non-standard cloud physics research data.

The work performed under this contract has been submitted in detail in a set of 23 monthly reports. Rather than summarizing these here, this report includes a full set of updated documentation and operating instructions for the programs developed under this contract.

2.1 KN1UTIL

2.1.1 Program Description

Program KN1UTIL was written to examine or copy a PMS-1D data tape to verify the correct operation of the associated hardware. It also provides an input summary that is invaluable to the checkout of the post processing programs that utilize this data.

KN1UTIL is usually executed with cards through the CDC 6600 batch processor and will produce either an output listing or a magnetic tape. It can list the input data in various ways:

1) an octal dump of each record
2) a decimal dump of each record
3) a decimal dump of any selected probe or VCO string
4) a decimal listing of the PMS status words

Each method gives a multi file reading capability and also a means to skip records when listing.

An additional facility of KN1UTIL is a copy option that allows various records from different files on the PMS-1D tape to be copied to a new tape in the same format.

The input data tape can come from three sources: the Kennedy recorders on the C130-A or C130-E aircraft or from the Learjet PMS-1D device after being preprocessed by LEARPMS.

2.1.2 CONTROL CARDS

```
JOBID,CM60000,T100,TP2.*            Prob. No.      Name
VSN,TAPE1=TAPENO,TAPE2=TAPENO.
ATTACH LGO,KN1UTILBIN,ID=GLASS,MR=1.
REQUEST,TAPE1,S,HI.
REQUEST,TAPE2,S,HI.
FILE(TAPE1,RT=U,BT=K,MRL=1024,MBL=1024,RB=1,BFS=105)
FILE(TAPE2,RT=U,BT=K,MRL=1024,MBL=1024,RB=1,BFS=105)
LDSET,FILES=TAPE1/TAPE2,PRESET=ZERO.
MAP,OFF.
LGO.
REWIND,BPARAM,CPARAM,DPARAM.**
COPY,BPARAM.**
COPY,CPARAM.**
COPY,DPARAM.**
7/8/9
DATA DECK
7/8/9
6/7/8/9
```

* If not duplicating a tape

1. change TP2 to TP1
2. remove TAPE2=TAPENO from VSN card
3. remove REQUEST TAPE2 card

** Remove the cards if status word dump is not desired

2.1.3 DATA CARDS

1. Decimal Dump - one data card

cc 2-4	DEC	
cc 5-7	number of files dumped	
cc 8-10	record indicator	
	i.e.	1 = every record
		2 = every other record
		6 = every sixth record

ex. to dump decimally, two files every 10th record

```
-DEC--2-10        - = blank
```

2. Octal Dump - one data card

cc 2-4	OCT
cc 5-7	same as decimal dump
cc 8-10	

ex. to dump octally, nine files every 100th record

```
-OCT--9100        - = blank
```

3. Selective Record Dump - n data cards (decimal only)

card 1

cc 2-4	REC
cc 5-7(rj)	number of files dumped
cc 8-10(rj)	record indicator

cards 2...n (one card for each set of records)

cc 1-6(rj)	starting record to dump
cc 7-12(rj)	ending record to dump

ex. to dump every 10th record
from 125 to 350 and
from 1000 to 1500

```
-REC--1-10
---125---350
--1000--1500      - = blank
```

4. Tape Copying - n data cards

card 1

cc 2-4	DUP
cc 5-7	number of files to copy

cards 2...n (one card for each file to be copied)

cc 1-6(rj)	number of records to skip before copying
cc 7-12(rj)	number of records to copy

ex. to create a tape of:
records 701 to 750 from file 1,
and records 25 to 50 from file 3,
the data deck is ...

```
-DUP--3
---700----50
-----0-----0
----24----26      - = blank
```

5. Selective Probe Dump (1 data card)

cc 2-4	DEC
cc 5-7	number of files dumped
cc 8-10	record indicator i.e. 1 = every record 2 = every other record 6 = every sixth record
cc 15	selected probe

BLANK/0 for regular decimal dump (OPTION 1)
1 for scatter probe only
2 for cloud probe only
3 for precip probe only
4 for VCO data only

ex. to dump decimally, 2 files every 10th record for Precip probe

-DEC--2-10----3 - = blank

2.1.4 Output Details

The DEC (decimal) and SEL (selected) output listings are shown in figure 1A and are identical in format. The R= and F= indicate the record and file numbers respectively. The format of this output is the same as the 64 word record structure illustrated in Appendix 3.

The probe select option of the decimal output is shown in figure 1B. In this case the VCO data was chosen (a 4 in column 15 of the DEC card). The first number on each data line is the PMS elapsed second counter followed by the probe designator, in this case VCO data. The thirteen VCO values follow. The real time clock (hours, minutes and seconds) output is at the end of the line.

The last set of output (figure 1C) is a listing of the status parameters. The literal B0, C0 or D0 denote the probe; scatter, cloud or precip. The first column lists the elapsed second counter. The next column shows the real time clock. The number in parenthesis at the top of this column is the elapsed second corresponding to this time. Thus since this number is 2, the elapsed seconds corresponding to this time is two more than that given in the first column. The other columns are the status values corresponding to the elapsed second counter ending in that particular digit. Refer to Appendix 1 for an explanation of these housekeeping values and to Appendix 4 for a listing of the parameters monitored each second.

```
 761 6613 4392 5004    0 4153 4605 3061 5983 5034    0    0    0    0 5320   14
 262    0    0    0    0    0    0    1    0    0    0    0    0    0    0    0
  48    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 116    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

 762 6611 4403 5004    0 4154 4386 3050 5983 5053    0    0    0    0 5321   14
2019    5    0    0    0    0    0    0    0    0    0    0    0    0    0    0
1374    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
2256    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

 763 6629 4408 5004    0 4154 4384 3051 5986 5066    0    0    0    0 5322   14
2378    4    0    0    0    0    0    0    0    0    0    0    0    0    0    0
1554    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
4285    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

F=  1.    R=  200
 360 6654 4007 5004    0 4261 4319 4361 6283 5211    0    0    0    0 5339   14
1485    1    9    4    3    4    1    2    3    2    1    0    0    1    0    0
1504    0    0    0    0    0    1    1    0    0    0    1    1    0    0    0
1485  193   75    9    2    0    0    0    0    0    0    0    0    0    0    0

 361 6655 3992 5004    0 4261 4334 4343 6284 5209    0    0    0    0 5340   14
 317    1    8    7    8    2    4    3    1    2    1    0    0    1    0    0
  54    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 133  238   63    8    1    0    0    0    0    0    0    0    0    0    0    0

 362 6673 3990 5004    0 4263 4345 4323 6286 5214    0    0    0    0 5341   14
2220    1    4    3    3    1    1    2    1    1    2    1    1    3    0    0
1353    0    0    0    1    1    0    0    0    0    0    0    0    2    0    0
2096  102   91   11    1    0    0    0    0    0    0    0    0    0    0    0

 363 6697 3999 5004    0 4265 4350 4306 6286 5232    0    0    0    0 5342   14
2123    1    0    9    3    4    0    3    2    2    2    0    1    0    2    0
1484    0    0    0    1    0    0    1    0    0    0    2    0    0    0    0
4114  205  143   14    2    1    0    0    0    0    0    0    0    0    0    0

F=  1.    R=  250
 160 6601 3673 5004    0 4361 4978 4436 6593 5222    0    0    0    0 5959   14
1486    0    1    3    5    2    0    2    1    0    1    0    0    0    0    0
1504    0    0    0    0    0    0    0    0    0    0    0    0    1    1    0
1485  114   22    1    0    0    0    0    0    0    0    0    0    0    0    0
```

Figure 1A: KNLUTIL Sample Output

```
  1,     R=  550
ECONDS =  536   VCO   DATA    7344   3268   5000     0   5231   4891   2569   7297   6543     0     0     0     0  17:09:35
ECONDS =  537   VCO   DATA    7342   3262   5000     0   5230   4890   2564   7290   6536     0     0     0     0  17:09:36
ECONDS =  538   VCO   DATA    7340   3257   5000     0   5231   4892   2583   7290   6534     0     0     0     0  17:09:37
ECONDS =  539   VCO   DATA    7345   3254   5000     0   5230   4890   2583   7293   6532     0     0     0     0  17:09:38

  1,     R=  600
ECONDS =  136   VCO   DATA    7096   2972   5001     0   5255   4901   2749   7403   6233     0     0     0     0  17:12:55
ECONDS =  137   VCO   DATA    7091   2969   5000     0   5254   4901   2749   7405   6233     0     0     0     0  17:12:56
ECONDS =  138   VCO   DATA    7092   2967   5001     0   5254   4900   2749   7406   6230     0     0     0     0  17:12:57
ECONDS =  139   VCO   DATA    7090   2964   5000     0   5254   4901   2749   7408   6236     0     0     0     0  17:12:58

  1,     R=  650
ECONDS =  336   VCO   DATA    6807   2806   5001     0   5289   4867   2593   7554   5872     0     0     0     0  17:16:15
ECONDS =  337   VCO   DATA    6804   2802   5001     0   5290   4865   2533   7555   5868     0     0     0     0  17:16:16
ECONDS =  338   VCO   DATA    6804   2801   5000     0   5290   4887   2593   7556   5866     0     0     0     0  17:16:17
ECONDS =  339   VCO   DATA    6802   2797   5001     0   5290   4887   2593   7556   5865     0     0     0     0  17:16:18

  1,     R=  700
ECONDS =  536   VCO   DATA    6816   2662   5001     0   5306   4880   2525   7627   5919     0     0     0     0  17:19:35
ECONDS =  537   VCO   DATA    6822   2663   5000     0   5307   4880   2525   7627   5926     0     0     0     0  17:19:36
ECONDS =  538   VCO   DATA    6825   2665   5001     0   5306   4879   2524   7627   5933     0     0     0     0  17:19:37
ECONDS =  539   VCO   DATA    6827   2667   5000     0   5306   4881   2525   7626   5937     0     0     0     0  17:19:38

  1,     R=  750
ECONDS =  736   VCO   DATA    7080   2800   4999     0   5295   4880   3159   7624   6321     0     0     0     0  17:22:55
ECONDS =  737   VCO   DATA    7077   2801   4998     0   5295   4882   3159   7625   6314     0     0     0     0  17:22:56
ECONDS =  738   VCO   DATA    7075   2799   4999     0   5295   4881   3159   7624   6313     0     0     0     0  17:22:57
ECONDS =  739   VCO   DATA    7074   2800   4999     0   5295   4881   3159   7626   6316     0     0     0     0  17:22:58

  1,     R=  800
ECONDS =  936   VCO   DATA    7166   2769   4999     0   5293   4872   3218   7637   6439     0     0     0     0  17:26:15
ECONDS =  937   VCO   DATA    7172   2792   4999     0   5293   4874   3218   7632   6448     0     0     0     0  17:26:16
ECONDS =  937   VCO   DATA    7172   2792   4999     0   5293   4874   3218   7632   6448     0     0     0     0  17:26:16
ECONDS =  938   VCO   DATA    7176   2796   4999     0   5298   4872   3212   7631   6454     0     0     0     0  17:26:17
ECONDS =  939   VCO   DATA    7183   2800   5000     0   5293   4873   3208   7630   6464     0     0     0     0  17:26:18

  1,     R=  850
ECONDS =  136   VCO   DATA    7236   2793   5001     0   5295   4869   3208   7615   6530     0     0     0     0  17:29:35
ECONDS =  137   VCO   DATA    7236   2794   4999     0   5295   4870   3204   7615   6530     0     0     0     0  17:29:36
ECONDS =  138   VCO   DATA    7236   2794   4999     0   5295   4870   3199   7615   6535     0     0     0     0  17:29:37
ECONDS =  139   VCO   DATA    7235   2795   5000     0   5295   4869   3198   7615   6532     0     0     0     0  17:29:38

  1,     R=  900
ECONDS =  336   VCO   DATA    7138   2719   4999     0   5295   4873   3304   7630   6422     0     0     0     0  17:32:55
ECONDS =  337   VCO   DATA    7137   2719   4999     0   5295   4871   3296   7629   6423     0     0     0     0  17:32:56
ECONDS =  338   VCO   DATA    7137   2721   4999     0   5295   4870   3296   7629   6423     0     0     0     0  17:32:57
ECONDS =  339   VCO   DATA    7138   2722   5000     0   5295   4871   3295   7628   6425     0     0     0     0  17:32:58

  1,     R=  950
ECONDS =  536   VCO   DATA    7209   2777   5000     0   5297   4864   3188   7630   6535     0     0     0     0  17:36:15
ECONDS =  537   VCO   DATA    7212   2776   4999     0   5296   4864   3186   7630   6539     0     0     0     0  17:36:16
ECONDS =  538   VCO   DATA    7212   2777   4999     0   5297   4862   3178   7630   6537     0     0     0     0  17:36:17
ECONDS =  539   VCO   DATA    7213   2778   4999     0   5296   4864   3178   7630   6532     0     0     0     0  17:36:18
```

Figure 1B: KNlUTIL Sample Output

ESEC	HHMMSS(?)	0	1	2	3	4	5	6	7	8	9
350	190451	1508	91	1284	1166	1556	2756	5147	2217	1507	91
360	190501	1508	91	1352	1154	1555	2756	5147	2217	1508	91
370	190511	1507	91	1374	1167	1555	2757	5146	2218	1507	91
380	190521	1508	91	1360	1165	1555	2757	5147	2217	1508	91
390	190531	1507	91	1351	1144	1555	2756	5147	2218	1507	91
400	190541	1508	91	1330	1119	1555	2756	5147	2218	1507	92
410	190551	1507	91	1303	1090	1556	2756	5147	2219	1506	91
420	190601	1507	91	1319	1121	1555	2756	5146	2219	1507	92
430	190611	1507	91	1362	1172	1555	2756	5146	2219	1508	91
440	190621	1507	91	1361	1171	1555	2755	5147	2219	1508	91
450	190631	1507	91	1360	1167	1555	2756	5147	2219	1506	91
460	190641	1507	92	1356	1155	1556	2756	5146	2220	1506	91
470	190651	1507	92	1347	1139	1556	2756	5147	2220	1506	91
480	190701	1507	92	1334	1120	1556	2755	5147	2221	1507	92
490	190711	1507	91	1308	1090	1556	2755	5147	2221	1507	91
0	190721	1508	91	1293	1069	1556	2755	5147	2221	1508	91
10	190731	1507	92	1299	1084	1555	2756	5146	2222	1506	91
20	190741	1507	92	1336	1131	1556	2755	5147	2222	1507	92
30	190751	1507	92	1364	1165	1556	2755	5147	2222	1507	91
40	190801	1508	91	1360	1164	1556	2755	5146	2223	1507	92
50	190811	1507	92	1365	1163	1555	2755	5147	2223	1507	92
60	190821	1507	91	1362	1156	1556	2754	5147	2223	1507	92
70	190831	1507	91	1349	1145	1555	2755	5146	2224	1507	91
80	190841	1508	91	1347	1128	1556	2755	5147	2223	1508	91
90	190851	1508	91	1325	1106	1555	2755	5147	2224	1508	91
100	190901	1507	92	1305	1079	1555	2756	5146	2224	1508	91
110	190911	1508	91	1283	1097	1555	2755	5147	2224	1506	91
120	190921	1508	91	1367	1161	1555	2755	5147	2225	1507	92
130	190931	1507	91	1363	1159	1556	2755	5147	2225	1507	92
140	190941	1507	92	1366	1158	1555	2755	5146	2226	1507	92
150	190951	1507	91	1356	1147	1555	2755	5146	2226	1507	92
160	191001	1507	92	1344	1131	1556	2754	5146	2225	1506	91
170	191011	1508	91	1329	1111	1555	2755	5147	2226	1508	91
180	191021	1506	91	1307	1077	1556	2755	5147	2225	1506	92
190	191031	1507	92	1290	1053	1556	2755	5146	2227	1507	92
200	191041	1507	92	1308	1077	1555	2755	5147	2227	1506	92
210	191051	1507	92	1356	1129	1556	2755	5147	2228	1507	92
220	191101	1508	92	1370	1155	1555	2756	5147	2228	1507	92
230	191111	1508	91	1373	1153	1555	2756	5147	2228	1507	92
240	191121	1507	92	1369	1151	1555	2756	5147	2228	1508	91
250	191131	1508	91	1374	1144	1556	2755	5147	2229	1507	92
260	191141	1507	92	1329	1077	1556	2755	5147	2229	1507	92
270	191151	1507	92	1300	1059	1555	2756	5147	2229	1507	92
280	191201	1507	92	1329	1115	1556	2755	5147	2229	1506	91
290	191211	1507	92	1369	1150	1555	2754	5146	2230	1507	92
300	191221	1507	92	1375	1157	1556	2754	5147	2230	1507	92
310	191231	1507	92	1369	1155	1555	2755	5147	2230	1507	92
320	191241	1507	91	1367	1154	1555	2755	5147	2230	1506	91
330	191251	1508	91	1363	1151	1555	2756	5147	2231	1507	91
340	191301	1508	91	1356	1134	1556	2755	5147	2231	1507	91

Figure 1C: KNLUTIL Sample Output

2.2 KNOLL1D

2.2.1 Program Description

Program KNOLL1D is the primary post processing program for data collected by the PMS-1D systems. These devices are currently on-board the C130E and LEAR aircraft. At an earlier time, however, data were also collected from a similar device on an older C130A aircraft.

Program KNOLL1D provides the user with a complete particle density distribution spectra in the range of 1 to 4650 microns. From this distribution a calculated set of meteorological parameters (i.e. Liquid Water Content (M), Radar Reflectivity (Z), Median Volume Diameter (D_o), Spectral Parameter (K), Form Factor (F), and Stability (S), are produced in tabular form. Environmental parameters such as temperature, dewpoint, etc. are also calculated and listed. In addition M, Z and D_o are produced graphically as line printer plots.

KNOLL1D is the first program executed in the data processing stream. It provides processed values in the form of tapes and cards for additional production programs.

The program is run under control of the CDC 6600 batch processor. Input is via both cards and tape. The C130 tape is recorded on a 7-track Kennedy recorder; the LEAR system uses a nine track Pertec recorder with a slightly different block size. Because of this the LEAR tape must be pre-processed using program LEARPMS (see Section 2.9). The output consists of listings, line printer plots, tapes and/or cards.

FILE DESCRIPTION

UNIT	TYPE	MEDIUM	DESCRIPTION
1	INPUT	TAPE	PMS-1D TAPE
2	OUTPUT	TAPE	OUTPUT SUMMARY TAPE
3	OUTPUT	PAPER	LISTING OF M, Z, D_o
4	OUTPUT	CARD	M AND Z
5	INPUT	CARD	INPUT DATA
6	OUTPUT	PAPER	ADDITIONAL OUTPUT*
7	OUTPUT	TAPE	M AND Z (USED IN RAPP)
9	OUTPUT	PAPER	LINE PRINTER PLOT OF M, Z, D_o
10	OUTPUT	PAPER	OUTPUT FILE

* The output file (TAPE10) may either be the default ABRES long listing or the abbreviated AFWL listing. In either case TAPE6 will contain the output NOT selected and may be viewed by adding the appropriate control cards.

2.2.2 Control Cards

```
JOBNR,CM66000,T600,TP1.                          PROB NO.      NAME
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
ATTACH,LGO,KNOLL1DBIN,ID=GLASS,MR=1.
REQUEST TAPE1,S,HI,VSN=PMSXXX.
REQUEST,TAPE2,*PF,SN=LYCPFI.*
REQUEST,TAPE7,*PF,SN=LYCPFI.**
FILE (TAPE1,RT=U,BT=K,MRL=1024,MBL=1024,RB=1,BFS=105)
LDSET,FILES=TAPE1,PRESET=ZERO.
MAP,OFF.
LGO.
CATALOG,TAPE2,PLOTDATA,ID=GLASS.*
CATALOG,TAPE7,RAPPDATA,ID=GLASS.**
REWIND,TAPE3,TAPE8,TAPE9.
COPY,TAPE3.
COPY,TAPE8.
COPY,TAPE9.
REWIND,TAPE6.***
COPY,TAPE6.***
EXIT(S)
REWIND,TAPE6.***
COPY,TAPE6.***
CATALOG,TAPE2,PLOTDATA,ID=GLASS.*
CATALOG,TAPE7,RAPPDATA,ID=GLASS.**
REWIND,TAPE3,TAPE8,TAPE9.
COPY,TAPE3.
COPY,TAPE8.
COPY,TAPE9.
7/8/9
```

DATA CARD

7/8/9

6/7/8/9

* for Plottape option must have REQUEST TAPE2 card

** for Rapptape option must have REQUEST TAPE7 card

*** for optional output

2.2.3 Data Cards

card 1: ID CARD

cc	1-10	FLT E78-NN	
	11-20	DD MON YY	
	21-30	PMSXXX	(INPUT TAPE)
	31-40	LYCXXX	(PLOT TAPE)
	41-50	LYCXXX	(RAPP TAPE)

card 2: TIME CARD

cc	1-15	START: HH:MM:SS	
	22-35	STOP: HH:MM:SS	
	43-65	ZERO SECONDS = HH:MM:SS	

cards 3 & 4: NAMELIST CARDS

$ SCOEF $	(SOUNDING COEFFICIENTS)
$ VCOEF $	(VCO CALIBRATIONS)

card 5: OPTION CARD

cc	1-5	ICRYS
	6-10	ICLK
	11-15	IDAT
	20	IPLT
	21-25	INTA
	30	ITMP
	31-35	JVCO
	36-40	NSKP
	45	IDEK

cc	50	IRAD
	55	INTRP
	60	IDMZ
	65	IVEL
	70	IFORM

card 6: OPTIONAL DATA

any RADIOSONDE or JVCO data required by switches set on the option card

card 7:

The following cards 7A-7D can be interspersed

card 7A: TYPE CARDS (OPTIONAL - 15 MAXIMUM)

1-4	EDIT	
6-13	HH:MM:SS	(START)
16-23	HH:MM:SS	(STOP)
25-26	CLOUD TYPE	
27-28	PRECIP TYPE	

card 7B: EDIT CARDS (OPTIONAL - 5 MAXIMUM)

1-4	EDIT	
6-13	HH:MM:SS	(START)
16-23	HH:MM:SS	(STOP)
26	PROBE 1	
28	PROBE 2	
30	PROBE 3	
31-54	CHANNELS TO BE EDITED (I3 FORMAT, 8 MAXIMUM)	

card 7C: HTOX CARDS (OPTIONAL - NO MAXIMUM)

1-4	HTOX
6-7	PARTICLE TYPE
9-10	EQUATION NUMBER
12-13	ARGUMENT TO BE CHANGED (1=m, 2=b, 3=BREAKPOINT(N))
15-30	NEW VALUE (REAL - F16.0)

card 7D: XTOD CARDS (OPTIONAL - NO MAXIMUM)

1-4	XTOD
6-7	PARTICLE TYPE
9-10	EQUATION NUMBER
12-13	ARGUMENT TO BE CHANGED (1=co, 2=ex, 3=BREAKPOINT(C))
15-30	NEW VALUE (REAL - F16.0)

NAMELIST DESCRIPTION

card 3: $SCOEF card

This card allows the coefficients of the pressure-height sounding equation to be changed.
Control variable: S(I) where I = 1 to 5

I	
1	first order coefficient
2	second order coefficient
3	third order coefficient
4	fourth order coefficient
5	fifth order coefficient

For example, to change the second order coefficient, the control variable is S(2) = new value.

card 4: $VCOEF card

This card allows the VCO calibration coefficients to be input. The default coefficients are 0,1 and 0. Thus each run must have the desired coefficients input.
Control variable: C(I,J)
where I = 1 to 3 and J = 1,10 for E Model
J = 1,5 for LEAR

I		J	E MOD	LEAR
1	intercept	1	indicated airspeed	air pressure
2	slope	2	temperature	delta-pressure
3	third order coef.	3	EWER	temperature
		4	n/a	dewpoint
		5	dew [illegible]t	LWC-JW
		6	LWC -J[illegible]	

J	E MOD
7	heading
8	air pressure (Kistler)
9	true airspeed
10-13	n/a

For example, to input the third order coefficient of JW, the control variable is C(3,6) = value.

card 5: OPTION CARD DESCRIPTION

cc 5	ICRYS	= 1	TYPING BY TEMPERATURE
		= 2	UNUSED
		= 3	TYPING BY MANUAL INPUT
10	ICLK	= 1	TIME FROM AIRCRAFT CLOCK
		= 2	TIME FROM PMS BUFFER
15	IDAT	= 0	PRELIMINARY DATA
		> 0	FINAL DATA
20	IPLT	= 0	PLOT TAPE NOT PRODUCED
		= 1	PLOT TAPE PRODUCED
22-25	INTA	= 0	FULL DATA
		> 0	AVERAGING INTERVAL IN SECONDS
30	ITMP	= 0	TEMPERATURE DETERMINATION BY VCO
		= 1	DETERMINATION BY STANDARD ATMOSPHERE
		= 2	TEMPERATURE DETERMINATION BY RADIOSONDE PROFILE
35	JVCO	= 0	CALCULATE VCO PARAMETERS
		> 0	NUMBER OF JVCO CARDS
40	NSKP	= 0	PROCESS FIRST FILE
		> 0	NUMBER OF FILES TO SKIP BEFORE PROCESSING
		< 0	NUMBER OF RECORDS TO SKIP BEFORE PROCESSING

cc			
45	IDEK	= 0	DECK NOT PUNCHED
		= 1	DECK PUNCHED
50	IRAD	= 0	RAPP TAPE NOT PRODUCED
		= 1	RAPP TAPE PRODUCED
55	INTRP	= 0	NO DATA INTERPOLATION
		= 1	DATA INTERPOLATION
60	IDMZ	= 0	NO DMZ PLOT
		= 1	DMZ PLOT
65	IVEL	= 0	USE TAS VCO
		= 1	USE STANDARD CALCULATION
70	IFORM	= 0	ABRES OUTPUT TO FILE10
		= 1	AFWL OUTPUT TO FILE10

NOTES

1. ICRYS

   For ICRYS=3 at least 1 TYPE card is required

2. ICLK

   For ICLK=1 PMS on time may be set to zero

3. IDAT

   for IDAT>0 IDAT is printed as FINAL # on page 2 of output

4. ITMP

   For ITMP=1 standard atmosphere equation is:

   $$T = 76.88288(P)^{0.190284}$$

   For ITMP=2 profile uses a maximum of 20 levels

5. JVCO

   For JVCO>0 allows VCO parameters to be manually input for specified time. This option overrides the ITMP selection

JVCO CARDS DESCRIPTION (OPTIONAL)

JVCO cards are required only if cc 34-35 on the option card is greater than zero. These cards override the VCO calculations; they supply the basic meteorological parameters necessary for processing. The input values are constant for the duration of the time specified. The card format follows.

cc	FORMAT	DESCRIPTION
1-10	A10	@HH:MM:SS@ interval start time
11-20	A10	@HH:MM:SS@ interval stop time
21-30	F10.0	PRESSURE (mb) } { free field
31-40	F10.0	AIRSPEED (knots) } { with
41-50	F10.0	TEMPERATURE (°C) } { decimal
51-60	F10.0	HEIGHT (feet) } { point

RADIOSONDE CARDS DESCRIPTION (OPTIONAL)

These cards are required only if the option card cc 30 is 2. They override the VCO temperature calculation by allowing the temperature to be determined by linear interpolation using the RADIOSONDE temperature-pressure profile. The first card contains the number of cards to follow (20 maximum). The remaining cards contain the RADIOSONDE profile. These cards must be in descending pressure sequence.

card 1

cc 1-2 number of levels

cards 2...n

cc 1-10 PRESSURE (mb)
11-20 TEMPERATURE (°C)

TYPE CARDS DESCRIPTION (OPTIONAL)

The ype cards are required only if the option card cc 5 is 3. These cards specify the particle type to be used for the selected interval. The cloud probe type and precip probe type may be different. The scatter probe is always type rain.

TYPE CARDS

cc	FORMAT	DESCRIPTION
1-4	A4	TYPE
5-14	A10	START TIME (@HR:MN:SC@)
15-24	A10	STOP TIME (@HR:MN:SC@)
25-26	I2	TYPE KEY* (CLOUD PROBE)
27-28	I2	TYPE KEY* (PRECIP PROBE)

* The TYPE KEY used is obtained from the particle type table on page

EDIT CARDS DESCRIPTION (OPTIONAL)

These cards allow selected particle channel counts to be edited. The current editing constraints are as follows:

To edit channel 1 or 15 - there must be two valid channels on one side

To edit channels 2-14 - there must be one valid channel on both sides

To edit channels 1 & 2 - there must be a valid channel 3

cc	FORMAT	DESCRIPTION
1-4	A4	EDIT
5-14	A10	START TIME (@HR:MN:SC@)
15-24	A10	STOP TIME (@HR:MN:SC@)
25-26	I2	PROBE NO. } { 1 = scatter
27-28	I2	PROBE NO. } { 2 = cloud
29-30	I2	PROBE NO. } { 3 = precip
31-33	I3	CHANNEL NO.
34-36	I3	CHANNEL NO.
37-39	I3	CHANNEL NO.
40-42	I3	CHANNEL NO.
43-45	I3	CHANNEL NO.
46-48	I3	CHANNEL NO.
49-51	I3	CHANNEL NO.
52-54	I3	CHANNEL NO.

HTOX CARDS DESCRIPTION (OPTIONAL)

The TOX cards are used to change the default intercept (b), slope (m) or breakpoint (N) parameters for each adjusted channel size equation. For example, to change the second slope for particle type 17 (Aggregate Plates and Dendrites) from 1.20 to 1.25 the following HTOX card is required:

cc	VALUE	DESCRIPTION
1-4	HTOX	CARD CODE (FIXED)
6-7	17	PARTICLE TYPE
9-10	02	SECOND EQUATION
12-13	01	SLOPE
15-30	1.25	NEW VALUE

XTOD CARDS DESCRIPTION (OPTIONAL)

The XTOD cards are used to change the default coefficients exponent (ex), or breakpoint (C) for each equivalent melted diameter equation. For example, to change the third exponent for particle type 23 (Rimed Dendrites) from 1.0 to 0.9 the following XTOD card is required:

cc	VALUE	DESCRIPTION
1-4	XTOD	CARD CODE (FIXED)
6-7	23	PARTICLE TYPE
9-10	03	THIRD EQUATION
12-13	02	EXPONENT
15-30	0.9	NEW VALUE

PARTICLE TYPE TABLE

TYPE	NAME
1	RAIN
3	WET SNOW
5	LARGE SNOW
7	SMALL SNOW
9	BULLET-ROSETTES
11	COLUMNS
13	NEEDLES
15	PLATE F
17	AGG P & D
19	DENDRITE FAMILY
21	GRAUPEL
23	RIMED DENDRITE
25	NOT USED
27	NOT USED
29	NOT USED

2.2.4 Output De ails

The irst five pages of a KNOLL1D printout show the input and output parameters for this particular run (fig. 2A-2E).

Page one consists of a "banner" page followed by the version number of the KNOLL1D program. Page two (figure 2B) is described as follows

1) flight identification and flight date
2) date and time of processing
3) the time corresponding to zero elapsed seconds also which clock is to be used "A/C" or "PMS"
4) the start and stop times
5) the input tape number (blank in this case)
6) if positive the number of files to skip before processing, if negative the number of records (0 in this case)
7) averaging interval (4)
8) whether interpolation is to be used or not
9) whether a plot tape is to be made and what its number is
10) whether a RAPP tape is to be made and what its number is
11) whether the line printer plot of M, Z and D_o is to be made
12) whether punched card output is to be made
13) the form of the output, preliminary or final
14) method of temperature calculation; either by VCO or radiosonde profile
15) how particle typing is determined; by temperature or type cards. If the type card option is used; a listing of probe, type and effective times is shown.

Page three lists the VCO calibrations and probe configurations used for this particular run. If the values for these

VCO's should be changed see the $VCOEF$ card.

Page four lists the adjusted class size equations for each particle type, this table may be changed by using HTOX cards.

Page five lists the equivalent melted diamter equations for each particle type, this table may be changed by using XTOD cards.

There are two different output formats generated by KNOLL1D; the standard ABRES (Advanced Ballistic Re-Entry Systems) and the abbreviated AFWL (Air Force Weapons Lab.). They both have two average intervals per output page. One of the ABRES intervals will be explained here. This will facilitate the AFWL description. All references are to figure 2F.

A) The number of one second data samples that were averaged to make this table
B) Which clock was used to derive time "AIRCRAFT" or "PMS"
C) the start and stop time of this interval
D) The time as calculated by converting elapsed seconds (I) to hours, minutes, and seconds and adding this to the PMS on time (H)
E) Flight identification
F) Particle typing indicator
G) Data analysis indicator
H) The real time that corresponds with a PMS TIME COUNT = 0
I) The number of seconds counted by the PMS-1D hardware since it was turned on. (three digits on the data tape - KNOLL1D adds the leftmost fourth digit upon rollover)

J) The channel number for reference

K) The center diameter for this channel of this probe. It is calculated by adjusting the channel number by HTOX equations (per particle type) and then being melted down by XTOD or equivalent melted diameter equations

L) The normalized number density. It is calculated by computing the number of particles that would be detected by this channel size in a cubic meter of sample volume. Then for comparison with the other channels it is normalized by dividing it by the channel barwidth.

K and L above are repeated once for each channel of each probe. Scatter on the left, cloud in the middle, and the precip probe on the right.

M) This is the column of calibrated VCO values. FRSOTPOINT becomes DEWPOINT when the temperature is greater than or equal to 0°C. There are two type of airspeed, CALC as derived from pressure, Δ pressure and temperature, or TRUE which is given by the true airspeed computer. The asterisk next to (m/sec) shows which airspeed is used as velocity in the calculation of sample volume. It may be changed by changing the IVEL variable on the option card. The values of "N/A" for a particular VCO means it is not applicable to this aircraft or version.

N) Total particle count in this size channel

O) The calculated liquid water content (LWC) of each probe is listed along with the cumulative average (from the beginning of this pass - as determined by TYPE cards) in parenthesis

P) The radar reflectivity (Z) of each probe.

Q) The spectral parameter (K) (i.e. the ratio of LWC to square root of Z) for each probe

R) The median volume diameter (D_o) for each probe.

S) If two TYPE cards contributed to this average this would read "CHANGED" rather than "FIXED" and if that were the case this particular average would be useless since the the values were calculated with different diameters and barwidths.

T) The particle types used to calculate center diameters

U) FORM FACTOR a non physical parameter FF = $K/C\sqrt{N_T}$ where $C = \frac{\pi}{6} \rho 10^{-3}$, and NT is the sum of number density for channel five of the cloud probe up to channel 15 of the precip probe

V) Stability factor (s) a number which reflects the homogeneity of the sample $S = \sqrt{N_T}/FF$

AA) Totals (O-R) for scatter probe

BB) Totals (O-R) for cloud probe

CC) Totals (O-R) for precip probe

DD) Totals (O-R) for the cloud and precip

EE) All channels marked with a # are channels whose sampling area overlaps that of the next probe. In this case channels 11-15 of the cloud probe overlaps channel one of the precip, so these channels are not included in the totals of cloud and precip.

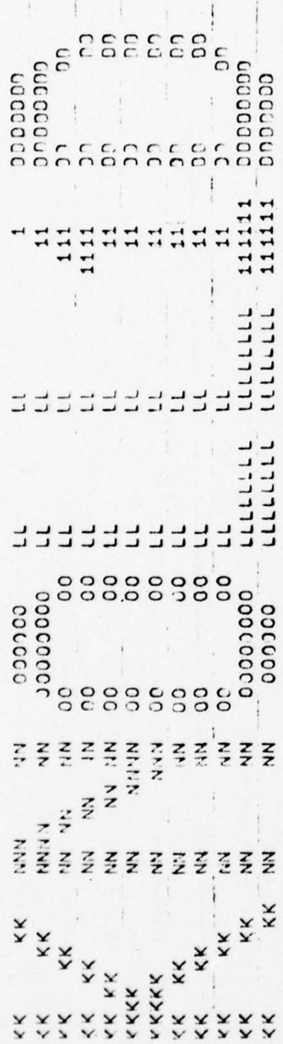
The AFWL output is very similar to the ABRES in content, however the format is different. It is designed to fit within an 8 1/2 x 11 paper and thus two "!" are printed, one at the top of the page and one at the bottom to form a cutting reference line. The significant differences in calculations between the AFWL and ABRES output are explained below, see figure 2G.

1) Sampling start time
2) Only the precip probe type is listed
3) The center diameter size, it is only adjusted and not melted
4) The normalized number density is calculated by dividing through by the unmelted barwidths
5) The LWC in gm/M^3 for each probe
6) The (D_o) median volume diameter for each probe
7) P - pressure in millibars
8) ALT - altitude in kilometers
9) TEMP - true temperature in centigrade
10) FROSTPOINT/DEWPOINT - in centrigrade
11) TAS - the selected airspeed in meters per second
12) Since LWC and D_o are both calculated from the melted equations, these totals reflect the elimination of any overlap between the cloud and precip probes.

File TAPE3 in figure 2I is self explanatory.

File TAPE9 (figure 2H) is the line printer plot of total D_o, LWC and Z versus time. The plot is on log scale with M indicating LWC, Z for Z and D representing D_o.

Figure 2A: KNOLL1D Sample Output



AFGL 1-DIMENSIONAL PARTICLE ANALYSIS PROGRAM
VERSION 3.07.04

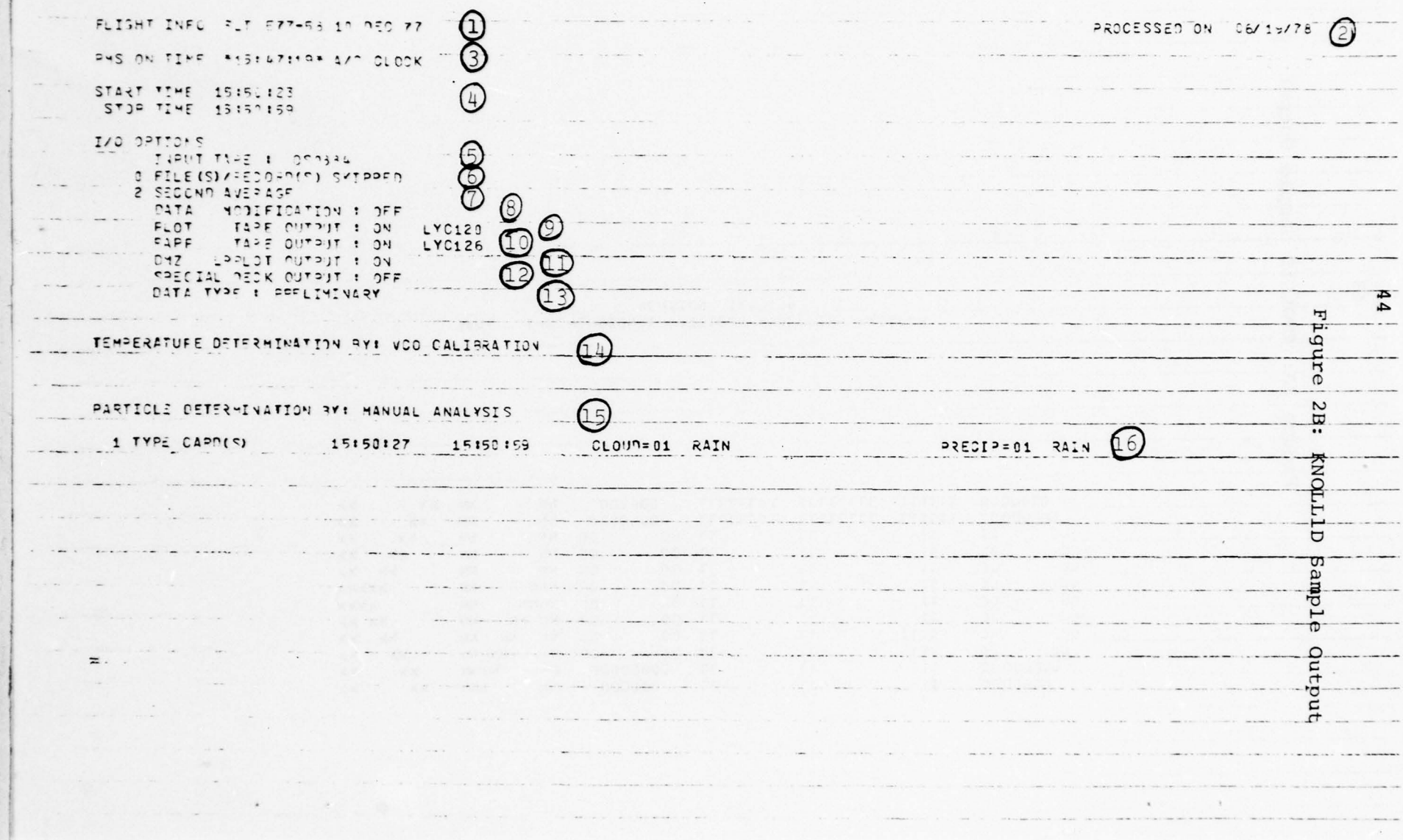


Figure 2B: KNOLLD Sample Output

VCO	PARAMETER	INTERCEPT	SLOPE	THIRD ORDER
1	INDICATED AIRSPEED	-.69086E+03	.18270E+00	-.88715E-05
2	TEMPERATURE	-.47947E+02	.91300E-02	.70589E-07
3	EWER	0.	.10000E+01	0.
4	NOT USED	0.	.10000E+01	0.
5	DEWPOINT	-.49387E+02	.99410E-02	0.
6	LWC-JW	-.30268E+01	.61000E-03	0.
7	HEADING	.17882E+03	-.36032E-01	0.
8	PRESSURE (ISTLER	.11409E+04	-.99065E-01	-.30692E-06
9	TRUE AIRSPEED	-.51347E+02	.51810E-01	0.

SOUNDING COEFFICIENTS
S(1) = 9.3083[illegible]0E+00
S(2) = -1.8153[illegible]0E-02
S(3) = 1.3063[illegible]1E-05
S(4) = -3.7813[illegible]0E-09
S(5) = -4.0781[illegible]0E-13

C130 PROBE CONFIGURATION		CLOUD	PRECIP
DIODE WIDTH	(MM)	.020	.300
DEPTH OF FIELD	(M)	.061 (MAX)	.264
EFFECTIVE APERTURE WIDTH (M)		(21-N)*WDM	(23-N)*WDM

Figure 2C: KNOLLID Sample Output

TYPE NUMBER	**HDX TABLE** NAME	EQUATION NUMBER	ADJUSTED CLASS M	B	BREAKPOINT (N)
1	RAIN	1	.830	.180	
3	WET SNOW	1	.830	.180	N LE 2.
		2	1.150	.180	
5	LARGE SNOW	1	1.150	.180	
7	SMALL SNOW	1	1.150	.180	
9	BULLET-ROSETTES	1	1.020	.320	
11	COLUMNS	1	1.300	.760	
13	NEEDLES	1	.200	3.040	N LE 1.
		2	1.230	1.080	
15	PLATE FAMILY	1	.940	.550	N LE 3.
		2	1.060	.020	
17	AGGREGATE P + D	1	.940	.550	N LE 3.
		2	1.200	-.440	
19	DENDRITE FAMILY	1	1.030	.716	
21	GRAUPEL	1	1.150	.180	
23	RIMED DENDRITE	1	1.150	.180	

Figure 2D: KNOLLID Sample Output

PE MBER	**XTOD TABLE** NAME	EQUATION NUMBER	EQ MELTED DIAMETER CO	EX	BREAKPT (CRSIZ)
1	RAIN	1	1.000E+00	1.000	
3	WET SNOW	1	1.000E+00	1.000	C LE 1.000 MM
		2	1.000E+00	.653	
5	LARGE SNOW	1	4.000E-01	.782	C LE 1.000 MM
		2	4.000E-01	.875	
7	SMALL SNOW	1	4.000E-01	.782	C LE .500 MM
		2	3.700E-01	.670	
9	BULLET-ROSETTES	1	2.560E-01	.667	C LE .200 MM
		2	4.380E-01	1.000	
11	COLUMNS	1	4.380E-01	1.000	
13	NEEDLES	1	2.560E-01	.670	
15	PLATE FAMILY	1	3.400E-01	.783	C LE 1.000 MM
		2	3.400E-01	.685	
17	AGGREGATE P + D	1	3.400E-01	.783	C LE 1.000 MM
		2	3.400E-01	.685	
19	DENDRITE FAMILY	1	3.400E-01	.780	
21	GRAUPEL	1	6.000E-01	.810	C LE .400 MM
		2	4.900E-01	.680	
23	RIMED DENDRITE	1	6.500E-01	1.000	C LE .200 MM
		2	4.200E-01	.560	C LE 2.000 MM
		3	3.100E-01	1.000	

Figure 2E: KNOLL1D Sample Output

2 SECOND AVERAGE AIRCRAFT TIME — FLIGHT INFORMATION — QUICK-LOOK ANALYSIS

START *15:50:27* STOP *15:50:28* — PMS BUFFER TIME *15:50:27* — FLT E77-58 10 DEC 77 — / P R E L I M I N A R Y / — ALL DATA IS SUBJECT TO CHANGE

PMS PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER) — PARTICLE TYPING BY MANUAL ANALYSIS — PMS ON TIME: *15:47:19* — PMS TIME COUNTS: 188

CHANNEL NUMBER	DIAMETER (MICRONS)	SCATTER PROBE	DIAMETER (MICRONS)	CLOUD PROBE	DIAMETER (MICRONS)	PRECIP PROBE			TOTAL SC	COUNTS CL	COUNTS PR
1	2.0	2.659E+08	23	0.	350	5.185E+02	PRESSURE-K (MB)	401.92	70	0	64
2	4.0	1.595E+08	43	1.466E+05	647	6.790E+01	EWER	5004.00	42	1	8
3	6.0	1.215E+08	62	6.891E+04	944	0.	HEIGHT (METERS)	7148.50	32	1	0
4	8.0	8.355E+07	82	0.	1241	0.	TRUE TEMP (DEG C)	-24.91	20	0	0
5	10.0	7.595E+07	102	2.787E+04	1538	0.	FROSTPOINT (DEG C)	-1.33	20	1	0
6	12.0	8.746E+07	122	6.192E+04	1835	0.	LWC-JW (GM/M**3)	-.07	10	3	0
7	14.0	5.317E+07	142	3.249E+04	2132	0.	IND AIRSPEED (KNOTS)	127.14	14	2	0
8	16.0	5.076E+07	161	1.333E+04	2429	0.	A PRESS (MB)	26.47	16	1	0
9	18.0	3.419E+07	181	1.446E+04	2726	0.	TACAN DIST (KM)	N/A	9	1	0
10	20.0	3.798E+07	201	1.578E+04	3023	0.	HEADING (DEG MAG)	37.69	14	1	0
11	22.0	2.279E+07	221#	1.736E+04	3320	0.	AIRSPEED-CALC (M/S)	96.91	6	1	0
12	24.0	3.039E+07	241#	3.857E+04	3617	0.	AIRSPEED-TRUE *(M/S)	119.25	8	2	0
13	26.0	4.177E+07	260#	6.510E+04	3914	0.	VERT ACCEL (G)	N/A	11	3	0
14	28.0	3.41[illegible]E+07	280#	2.460E+04	4211	0.	OBSERVER EVENT	N/A	9	1	0
15	30.0	7.596E+06	300#	0.	4508	0.	VISUAL CLOUD	N/A	2	0	0

	AA	BB	CC	DD			
LWC(GM/M**3)	7.637E-03(3.64E-03)	3.085E-02(3.08E-02)	6.360E-03(6.36E-03)	1.195E-02(1.20E-02)	PARTICLE TYPES	FIXED	
Z(MM**6/M**3)	9.707E-05(9.71E-05)	8.853E-01(8.85E-01)	1.781E+00(1.78E+00)	1.827E+00(1.83E+00)	RAIN / RAIN	/ RAIN	
K(M/T**0.5)	3.692E-01	3.278E-02	4.766E-03	8.641E-03	FORM FACTOR =	.2119	
DO(MICRONS)	2.478E+01	2.548E+02	4.734E+02	2.353E+02	S FACTOR =	375.9	

2 SECOND AVERAGE AIRCRAFT TIME — FLIGHT INFORMATION — QUICK-LOOK ANALYSIS

START *15:50:29* STOP *15:50:30* — PMS BUFFER TIME *15:50:29* — FLT E77-58 10 DEC 77 — / P R E L I M I N A R Y / — ALL DATA IS SUBJECT TO CHANGE

PMS PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER) — PARTICLE TYPING BY MANUAL ANALYSIS — PMS ON TIME: *15:47:19* — PMS TIME COUNTS: 190

CHANNEL NUMBER	DIAMETER (MICRONS)	SCATTER PROBE	DIAMETER (MICRONS)	CLOUD PROBE	DIAMETER (MICRONS)	PRECIP PROBE			TOTAL SC	COUNTS CL	COUNTS PR
1	2.0	3.798E+08	23	0.	350	4.781E+02	PRESSURE-K (MB)	401.92	100	0	59
2	4.0	1.557E+08	43	0.	647	9.336E+01	EWER	5003.50	41	0	11
3	6.0	1.367E+08	62	0.	944	0.	HEIGHT (METERS)	7148.50	36	0	0
4	8.0	8.355E+07	82	0.	1241	0.	TRUE TEMP (DEG C)	-24.92	22	0	0
5	10.0	4.937E+07	102	0.	1538	0.	FROSTPOINT (DEG C)	-1.33	13	0	0
6	12.0	7.216E+07	122	0.	1835	0.	LWC-JW (GM/M**3)	-.07	19	0	0
7	14.0	3.419E+07	142	1.624E+04	2132	0.	IND AIRSPEED (KNOTS)	127.17	9	1	0
8	16.0	3.039E+07	161	2.679E+04	2429	0.	A PRESS (MB)	26.48	8	2	0
9	18.0	4.178E+07	181	1.446E+04	2726	0.	TACAN DIST (KM)	N/A	11	1	0
10	20.0	1.519E+07	201	1.577E+04	3023	0.	HEADING (DEG MAG)	37.62	4	1	0
11	22.0	2.279E+07	221#	1.736E+04	3320	0.	AIRSPEED-CALC (M/S)	96.93	6	1	0
12	24.0	1.899E+07	241#	0.	3617	0.	AIRSPEED-TRUE *(M/S)	119.25	5	0	0
13	26.0	3.039E+07	260#	0.	3914	0.	VERT ACCEL (G)	N/A	8	0	0
14	28.0	2.279E+07	280#	2.461E+04	4211	0.	OBSERVER EVENT	N/A	6	1	0
15	30.0	1.139E+07	300#	2.334E+04	4508	0.	VISUAL CLOUD	N/A	3	1	0

LWC(GM/M**3)	2.817E-03(2.82E-03)	1.970E-02(1.97E-02)	7.165E-03(7.17E-03)	1.107E-02(1.11E-02)	PARTICLE TYPES	FIXED
Z(MM**6/M**3)	7.563E-05(7.57E-05)	7.475E-01(7.48E-01)	2.318E+00(2.32E+00)	2.352E+00(2.36E+00)	RAIN / RAIN	/ RAIN
K(M/T**0.5)	3.217E-01	2.279E-02	4.706E-03	7.204E-03	FORM FACTOR =	.2500
DO(MICRONS)	2.496E+01	2.848E+02	5.272E+02	3.531E+02	S FACTOR =	220.1

Figure 2F: KNOLLIDE Sample Output

AFWL CIRRUS STUDY BY AFGL

FLIGHT FZZ-5b ON 10 DEC 77 2 SECOND AVERAGING
INTERVAL START *15:50:59* (1)
PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM)
TYPE: RAIN (2)

(3) SIZE (MM)	(4) SCATTER PROBE	SIZE (MM)	CLOUD PROBE	SIZE (MM)	PRECIP PROBE		
						P (MB)	(7)
2	3.48E+08	23	0.	350	1.03E+03	401.0	
4	1.61E+08	43	0.	647	2.31E+02	ALT (KM)	(8)
6	8.04E+07	62	0.	944	2.70E+01	7.149	
8	5.74E+07	82	0.	1241	0.		
10	7.27E+07	102	0.	1538	0.	TEMP (C)	(9)
12	1.91E+07	122	0.	1835	0.	-25.0	
14	4.59E+07	142	0.	2132	0.		
16	1.91E+07	161	0.	2429	0.	FROSTPOINT	
18	2.68E+07	181	0.	2726	0.	-1.3	(10)
20	1.15E+07	201	1.59E+04	3023	0.		
22	1.91E+07	221	1.75E+04	3320	0.	TAS (M/S)	(11)
24	0.	241	0.	3617	0.	118.3	
26	7.66E+06	260	2.19E+04	3914	0.		
28	1.15E+07	280	0.	4211	0.		
30	7.66E+06	300	0.	4508	0.		
						TOTALS	
(5) LWC	1.48E-03		7.35E-03		2.02E-02	2.16E-02	(12)
(6) NO D	21		252		596	576	

Figure 2G: KNOLL1D Sample Output

FLIGHT:E77-58 DATE: 10 DEC 77

TIME	DO(MICRONS)	M(GM/M3)	Z(MM6/M3)
15:50:29	3.531E+02	1.117E-02	2.362E+00
15:50:31	3.714E+02	1.514E-02	4.631E+00
15:50:33	3.695E+02	1.235E-02	4.113E+00
15:50:35	4.875E+02	1.045E-02	4.156E+00
15:50:37	3.994E+02	1.633E-02	6.646E+00
15:50:39	2.112E+02	2.272E-02	7.761E+00
15:50:41	4.054E+02	1.901E-02	5.637E+00
15:50:43	4.744E+02	2.740E-02	7.740E+00
15:50:45	3.237E+02	2.249E-02	4.440E+00
15:50:47	3.752E+02	1.734E-02	3.927E+00
15:50:49	5.046E+02	1.383E-02	8.099E+00
15:50:51	5.360E+02	1.676E-02	1.528E+01
15:50:53	4.959E+02	1.728E-02	5.155E+00
15:50:55	5.925E+02	2.433E-02	1.296E+01
15:50:57	5.774E+02	3.083E-02	1.373E+01
15:50:59	5.761E+02	2.158E-02	1.137E+01

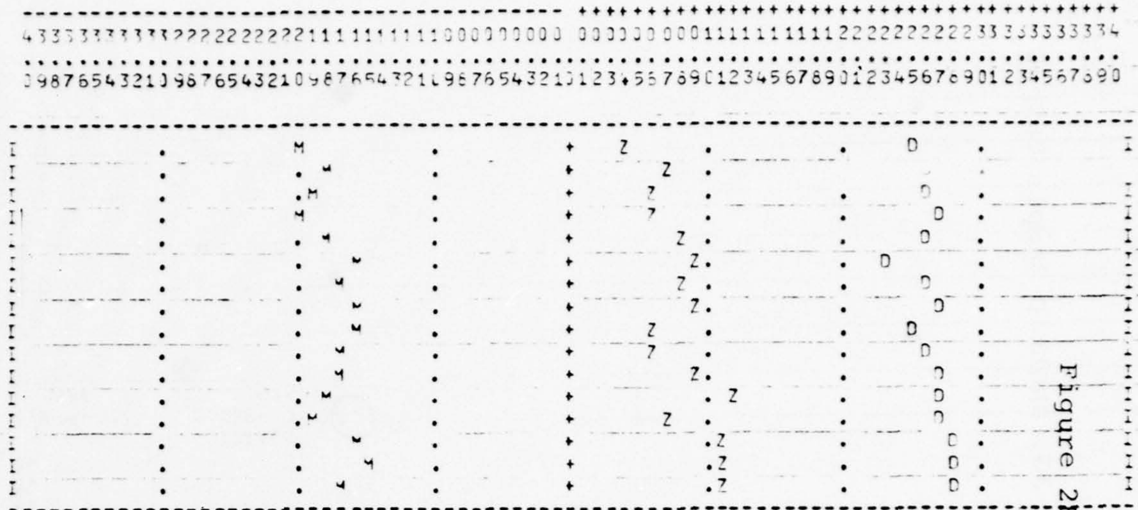


Figure 2H: KNOLL1D Sample Output

TIME	--- LIQUID WATER CONTENT (GM/M**3) --- SCATTER	CLOUD	PRECIP	TOTAL	--- RADAR REFLECTIVITY(MM**6/M**3) --- SCATTER	CLOUD	PRECIP	TOTAL	---MEDIAN VOLUME DIAMETER(MICRONS) --- SCATTER	CLOUD	PRECIP	TOTAL
5:50:23*	2.767E-03	3.672E-02	1.432E-02	2.339E-02	7.356E-05	1.056E+00	5.971E+00	6.081E+00	2.408E+01	2.538E+02	5.371E+02	3.120E+02
5:50:25*	4.382E-03	6.143E-02	1.434E-02	2.102E-02	1.312E-04	2.127E+00	1.487E+01	1.493E+01	2.549E+01	2.634E+02	5.762E+02	3.005E+02
5:50:27*	3.677E-03	3.085E-02	6.360E-03	1.195E-02	9.707E-05	8.853E-01	1.781E+00	1.827E+00	2.478E+01	2.546E+02	4.734E+02	2.353E+02
5:50:29*	2.817E-03	1.970E-02	7.153E-03	1.107E-02	7.668E-05	7.475E-01	2.719E+00	2.362E+00	2.498E+01	2.643E+02	5.272E+02	3.531E+02
5:50:31*	1.924E-03	1.855E-02	9.369E-03	1.514E-02	5.033E-05	4.567E-01	4.767E+00	4.831E+00	2.321E+01	2.422E+02	5.892E+02	3.714E+02
5:50:33*	4.475E-03	1.223E-02	8.543E-03	1.235E-02	1.303E-04	2.572E-01	4.077E+00	4.113E+00	2.529E+01	2.207E+02	5.409E+02	3.635E+02
5:50:35*	2.052E-03	1.970E-02	7.429E-03	1.045E-02	4.933E-05	7.662E-01	4.179E+00	4.166E+00	2.237E+01	2.643E+02	6.060E+02	4.679E+02
5:50:37*	2.264E-03	2.503E-02	1.123E-02	1.693E-02	5.963E-05	6.721E-01	6.586E+00	6.646E+00	2.456E+01	2.414E+02	5.505E+02	3.974E+02
5:50:39*	2.113E-03	1.673E-02	1.122E-02	2.272E-02	4.863E-05	2.722E-01	7.606E+00	7.761E+00	2.257E+01	2.033E+02	5.843E+02	2.112E+02
5:50:41*	1.730E-03	4.075E-02	1.338E-02	1.901E-02	4.333E-05	1.155E+00	5.764E+00	5.637E+00	2.366E+01	2.467E+02	5.460E+02	4.054E+02
5:50:43*	2.184E-03	2.346E-02	1.965E-02	2.340E-02	6.023E-05	6.723E-01	7.706E+00	7.740E+00	2.370E+01	2.562E+02	5.341E+02	4.744E+02
5:50:45*	1.999E-03	2.724E-02	1.399E-02	2.249E-02	5.004E-05	9.064E-01	4.719E+00	4.440E+00	2.338E+01	2.720E+02	5.095E+02	3.233E+02
5:50:47*	2.270E-03	2.733E-02	1.227E-02	1.784E-02	5.857E-05	8.626E-01	3.653E+00	3.927E+00	2.294E+01	2.460E+02	5.166E+02	3.752E+02
5:50:49*	1.578E-03	1.327E-02	1.592E-02	1.839E-02	3.837E-05	5.365E-01	8.063E+00	8.099E+00	2.247E+01	2.936E+02	5.657E+02	5.046E+02
5:50:51*	1.227E-03	7.972E-03	1.451E-02	1.676E-02	3.074E-05	2.733E-01	1.525E+01	1.528E+01	2.352E+01	2.769E+02	6.042E+02	5.330E+02
5:50:53*	1.447E-03	1.143E-02	1.138E-02	1.320E-02	3.855E-05	4.760E-01	5.143E+00	5.155E+00	2.526E+01	2.967E+02	5.316E+02	4.959E+02
5:50:55*	1.331E-03	1.073E-02	2.263E-02	2.486E-02	3.565E-05	3.477E-01	1.293E+01	1.295E+01	2.325E+01	2.720E+02	6.182E+02	5.925E+02
5:50:57*	1.359E-03	1.257E-02	2.677E-02	3.033E-02	3.685E-05	3.747E-01	1.372E+01	1.373E+01	2.429E+01	2.472E+02	5.947E+02	5.774E+02
5:50:59*	1.482E-03	7.350E-03	2.023E-02	2.156E-02	3.622E-05	1.988E-01	1.135E+01	1.137E+01	2.188E+01	2.526E+02	5.966E+02	5.761E+02
5:51:01*	1.362E-03	1.630E-02	2.798E-02	3.056E-02	3.956E-05	4.938E-01	2.486E+01	2.489E+01	2.570E+01	2.591E+02	6.365E+02	6.045E+02

Figure 2I: KNOLL1D Sample Output

2.3 KNPLT1D

2.3.1 Program Description

This program produces six different types of plots displaying the processed PMS-1D data in different forms. The input tape used is produced by program KNOLL1D (see Appendix 5 for the tape format); it contains averaged data, one record per average interval. In addition this program can read a processed tape containing LEARJET data. This tape is processed by another contractor and sent to LYC. The format for this tape is shown in Appendix 10.

Each plot type to be produced requires one plot request card. This card contains the information necessary to produce the plot (start time, stop time, etc.) with the appropriate title. The details of the plot request cards are included in Section 2.3.3.

To reduce plotting time and paper consumption the plots are produced on 35 mm film. The following sections explain in detail the plots available.

Control Cards (LEAR)

```
JOBNR,CM170000,T600,TP1,STMFB,NT1.                    PROB. NO.   NAME
REQUEST,TAPE39,RING,MT,VSN=WTCRT.
PAUSE. PLS  PUT WT NUMBERS IN DAYFILE
VSN,TAPE1=LEARTP/NT.
PAUSE. TAPE1 IS 9 TRACK PE
REQUEST,TAPE1,PE,L.
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
ATTACH,CRT,OFFLINECRT.
SETNAME(LYCPFI)
FILE(TAPE1,RT=U,BT=K,MRL=2100,MBL=2100,RB=1,BFS=212)
LIBRARY(CRT)
ATTACH,KP,KNPLT1D,ID=GLASS,MR=1.
ATTACH,P0,PLOTLIB0,ID=GLASS,MR=1.
ATTACH,P1,PLOTLIB1,ID=GLASS,MR=1.
ATTACH,P3,PLOTLIB3,ID=GLASS,MR=1.
ATTACH,P4,PLOTLIB4,ID=GLASS,MR=1.
LDSET,PRESET=ZERO,FILES=TAPE1.
LOAD(KP,P0,P1,P3,P4)
EXECUTE.
7/8/9
-DATA CARDS-
6/7/8/9
```

2.3.2 Control Cards (C130E)

```
JOBNR,CM1 )000,T600,TP2,STMFB.              PROB. NO.      NAME
REQUEST,TAPE39,RING,MT,VSN=WTCRT.
PAUSE. PLS PUT WT NUMBERS IN DAYFILE
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
ATTACH,CRT,OFFLINECRT.
SETNAME(LYCPFI)
LIBRARY(CRT)
REQUEST,TAPE2,MT,VSN=LYCXXX      (FROM KNOLL1D)
ATTACH,KP,KNPLT1D,ID=GLASS,MR=1.
ATTACH,P0,PLOTLIB0,ID=GLASS,MR=1.
ATTACH,P1,PLOTLIB1,ID=GLASS,MR=1.
ATTACH,P3,PLOTLIB3,ID=GLASS,MR=1.
ATTACH,P4,PLOTLIB4,ID=GLASS,MR=1.
LDSET,PRESET=ZERO
LOAD(KP,P0,P1,P3,P4)
EXECUTE.
7/8/9
-DATA CARDS-
6/7/8/9
```

2.3.3 Data Cards

The first data card is the information card; it appears only once.

Each plot type requires a plot request card. These request cards are unlimited and have the same format. The cards are divided into 16 fields. Each plot type requires certain fields to be used; all the unused fields may be left blank.

card 1. information card

VAR	cc	FORMAT	FUNCTION
PLT	1-3	A3	plot type: PEN or CRT
CLK	5	I1	clock: 1=A/C 2=PMS
IOUT	7	I1	0 = summary only 1 = date & summary
FLID	11-20	A10	flight id: FLT XYR-NN
	21-30	A10	date: DD MON YR
OPT	45	I1	0 = standard data 1 = LEARJET data
INT	49-50	I2	averaging interval (OPT = 1 only)

cards 2...n plot request cards

cc	FORMAT	FUNCTION
1	I1	field 1
3	I1	field 2
5-10	I6	field 3
15-20	I6	field 4
22-25	I4	field 5

cc	FORMAT	FUNCTION
27-30	I4	field 6
32-35	I4	field 7
37-40	I4	field 8
42-45	I4	field 9
47-50	I4	field 10
52-55	I4	field 11
57-60	I4	field 12
62-65	I4	field 13
67-70	I4	field 14
72-75	I4	field 15
77-80	I4	field 16

Cards 2 through n may appear in any sequence, however, considerable time is saved if cards with same time limits are consecutive.

The following page, "Request card summary" shows the required fields for each plot type.

REQUEST CARD SUMMARY

FIELD	cc	SCATTER	MZHIST	VCOHIST	SPECTRA	DO	VCOPLOT
1	1	1	2	3	4	5	6
2	3				probe		number
3	5-10	start	start	start	start	start	start
4	15-20	stop	dur	dur	stop	stop	stop
5	22-25	pass	pass		min }bl	pass	h axis code
6	27-30	htkm	htkm		max }bl	htkm	v axis code
7	32-35	minLWC*	minLWC*		min }br	minLWC*	type code
8	37-40	minEXP	minEXP		max }br	minEXP	h axis code **
9	42-45	maxLWC	maxLWC		min }ml	maxLWC	v axis code **
10	47-50	maxEXP	maxEXP		max }ml	maxEXP	type code
11	52055				min }mr		h axis code
12	57-60				max }mr		v axis code
13	62-65				min }tl		type code
14	67-70				max }tl		h axis code
15	72-75				min }tr		v axis code
16	77-80				max }tr		type code

start = start time (hhmmss)
stop = stop time (hhmmss)
dur = duration in seconds
pass = pass number
htkm = height (km)·10
i.e. 6.5 km = 65
probe = 1; scatter

probe = 2; cloud
probe = 3; precip
number = number of plots (max=4)
min, max = LWC limits
bl, br = bottom left, bottom right
ml, mr = middle left, middle right
tl, tr = top left, top right
* minLWC,EXP = minimum acceptable LWC
$= (\text{minLWC}) \cdot 10^{\text{minEXP}}$
maxLWC,EXP = maximum acceptable LWC
$= (\text{maxLWC}) \cdot 10^{\text{maxEXP}}$
type code = 1 scatter plot
type code = 2 line plot

** AXIS codes are shown in Appendix 6

SCATTER PLOTS

This ption produces two plots of LOG M vs. LOG Z. Plot one uses Precip Probe data only and plot two uses total data. A least squares linear fit is drawn through the data. The coefficients appear in the form M = A*Z**B.

INPUT CARD:

field 1	1	
field 3	start time	(HHMMSS)
field 4	stop time	(HHMMSS)
field 5	pass	(rj)
field 6	HTKM*10	(rj)
	i.e. 30 km = 300	
	27.2km = 272	

HISTOGRAMS

This option produces two histograms, the first, LOG M vs. time, and the second, LOG Z vs. time. Each histogram contains three plots, one for each probe. The time axis is set for a 300 second maximum, however, less data may be plotted.

INPUT CARD:

field 1	2	
field 3	start time	(HHMMSS)
field 4	duration seconds	(rj)
field 5	pass	(rj)
field 6	HTKM*10	(rj)

VCO's

This option produces three plots with two VCO's per plot. The six VCO's plotted are not variable. They are: Magnetic Heading, LWC(JW), Temperature, Dewpoint, Pressure, and Acceleration. The scales for Acceleration and LWC(JW) are fixed at $\pm$ 1g and -.1 to +.8 gm/m^3 respectively. The remaining VCO's have fixed ranges but the scale slides to plot as many points as possible. The fixed ranges are: Pressure (30 mb), Temperature (12°C), Dewpoint (12°C), and Heading (deg). The time axis is set for a 300 second maximum, however, less data may be plotted.

INPUT CARD:

field 1	3
field 3	start time (HHMMSS)
field 4	duration seconds (rj)

DENSITY SPECTRA

This option produces six plots of number density vs. equivalent melted diameter. Each plot uses only data from the specified probe for six liquid water content bands. The LWC bands are variable but the probe must be the same for all six plots. If the particle type remains constant for the entire interval, an average line is drawn through the data. Also, the cumulative percent mass is superimposed on each plot.

INPUT CARD:

field 1	4		
field 2	probe		(1=sc, 2=cl, 3=pr)
field 3	start time		(HHMMSS)
field 4	stop time		(HHMMSS)
field 5	min	BL	rj
field 6	max		rj
field 7	min	BR	rj
field 8	max		rj
field 9	min	ML	rj
field 10	max		rj
field 11	min	MR	rj
field 12	max		rj
field 13	min	TL	rj
field 14	max		rj
field 15	min	TR	rj
field 16	max		rj

The min and max values are the lower and upper limits of each LWC band. The LWC limits are in units of mg/M^3 with the 10^{-3} exponent omitted. Since there are four columns per limit, the absolute range of limits is from 1 = .001 mg/M^3 = 1 mg/M^3 to 9999 ≈ 10.0 gm/M^3 = 10^4 mg/M^3.

The two letter code BL, MR, etc. indicate which plot on the page is used. The plots are oriented as follows:

TL	TR
ML	MR
BL	BR

Less than six plots may be utilized by leaving the appropriate columns on the input card blank.

MEDIAN VOLUME DIAMETER

The Median Volume Diameter module produces seven plots of the following form.

D_o vs. $(Z/M)^{1/3}$	Precip only
D_o vs. $(Z/M)^{1/3}$	Cloud & Precip
D_o vs. K	Precip only
D_o vs. K	Cloud & Precip
ND_o^4/M vs. D/D_o	Precip only
ND_o^4/M vs. D/D_o	Cloud only
ND_o^4/M vs. D/D_o	Cloud & Precip

INPUT:

field 1	5	
field 3	start time	(HHMMSS)
field 4	stop time	(HHMMSS)
field 5	pass	(rj)
filed 6	HTKM*10	(rj)

VCO PLOT

This module produces a maximum of four plots per input card. The plots are any VCO, LWC, or X versus any other VCO, LWC or Z. There are two types of plotting: scatter or line. This option does not have a 300 point maximum, hence the plots can be run for an entire flight.

In the special case of plotting JW Liquid Water Content vs. Height an additional option is provided. This allows for all the data points to be shifted by some reference equation. The information for this adjustment is on a -$ADJUST card. This card must immediately follow the input card which specifies the JW-LWC vs. HEIGHT plot.

INPUT CARD:

field 1	6		
field 2	# number of plots this card (4 max)		
field 3	start time (HHMMSS)		
field 4	stop time (HHMMSS)		
field 5	horizontal axis		(rj)
field 6	vertical axis	Plot 1	(rj)
field 7	type		(rj)
field 8	horizontal axis		(rj)
field 9	vertical axis	Plot 2	(rj)
field 10	type		(rj)
field 11	horizontal axis		(rj)
field 12	vertical axis	Plot 3	(rj)
field 13	type		(rj)
field 14	horizontal axis		(rj)
field 15	vertical axis	Plot 4	(rj)
field 16	type		(rj)

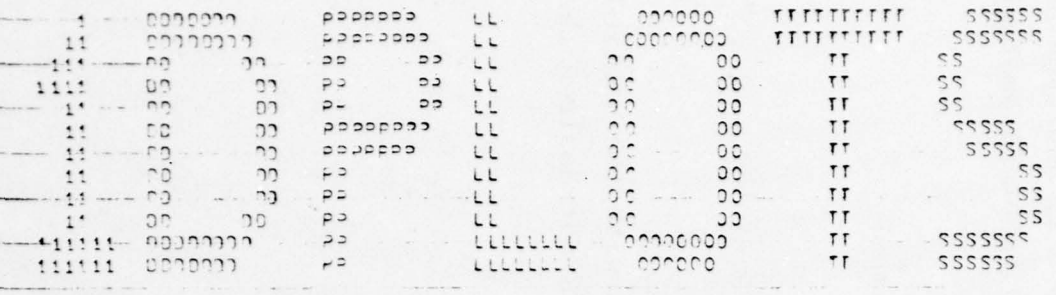
JW-LWC ADJUSTMENT CARD

If a VCO plot request card specifies a LWC-JW vs. HEIGHT plot, (i.e. h axis code = 5, v axis code = 2, and type code = 0) the next card must contain the adjustment parameters. The required parameters are:

L = number of levels (10 maximum)
XJ = origin of the level
SL = slope of the level
HT = height (meters) at the top of the level

The card uses a standard namelist format with the control variable being $ADJUST. If the option is not desired the card must be

```
$ADJUST L=0, $END
```



AFGL 1-DIMENSIONAL PARTICLE ANALYSIS PLOTTING PROGRAM
VERSION 2.13.02

FLT 577-51
10 DEC 77
PROCESSED ON 06/22/78
AT 20.50.02

Figure 3A: KNPLTLD $ample Output

```
PLOT  1   SCATTER
      START:150600   STOP:151200      PASS= 1      HTKM=   0      MINIMUM LWC= 1.000E-10 GRAMS      MAXIMUM LWC= 1.000E+10 GRAMS

     CLOUD   105 POINTS USED

 LEAST SQUARE FIT          Y = ( 4.5825E-01)X + (-2.0418E+00)

                           Y = ( 9.0627E-03)X** ( 4.5825E-01)

 X LOG MEAN= -2.314(4.8643E-03)                    Y LOG MEAN= -3.102(7.9047E-04)
 X LOG STD =  1.255(1.8103E+01)                    Y LOG STD =   .592(7.9054E+00)

     PRECIP   105 POINTS USED

 LEAST SQUARE FIT          Y = ( 5.2543E-01)X + (-2.9530E+00)

                           Y = (1.1144E-03)X** ( 5.2543E-01)

 X LOG MEAN=   .030(1.0706E+01)                    Y LOG MEAN= -2.937(1.1551E-03)
 X LOG STD =   .353(7.1235E+00)                    Y LOG STD =   .466(2.9226E+00)

     TOTAL   105 POINTS USED

 LEAST SQUARE FIT          Y = ( 3.5731E-01)X + (-2.7249E+00)

                           Y = ( 1.8639E-03)X** ( 3.5731E-01)

 X LOG MEAN= -.237(5.0415E-01)                     Y LOG MEAN= -2.831(1.4749E-03)
 X LOG STD =  1.172(1.4345E+01)                    Y LOG STD =   .468(3.0796E+00)
 4K LOG MEAN=  .317(2.0773E+01)
```

Figure 3B: KNPLTLD Sample Output

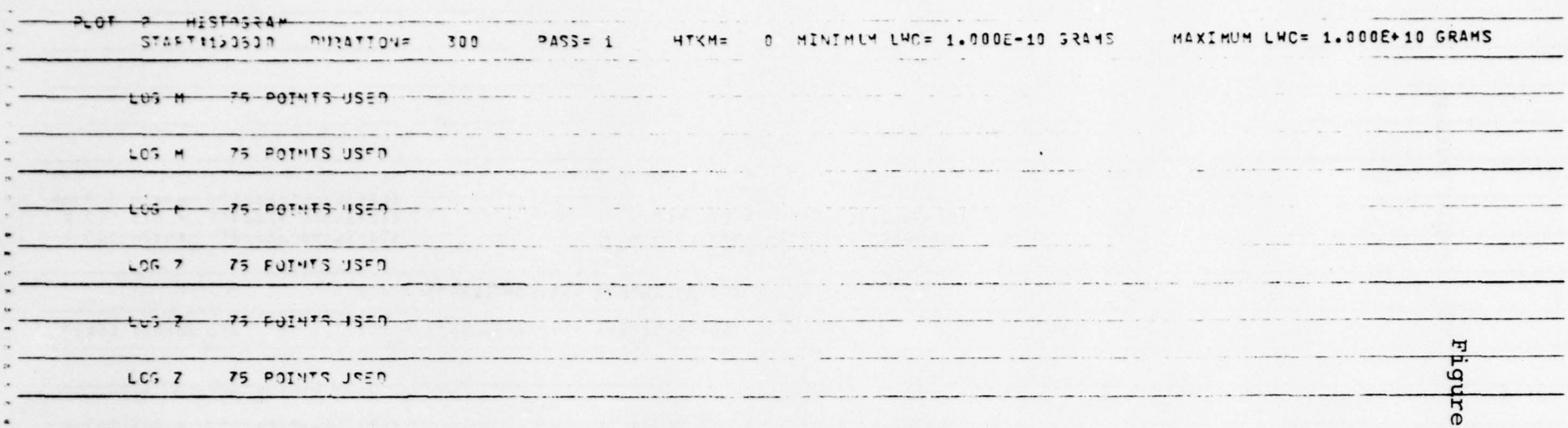


Figure 3C: KNPLT1D Sample Output

Figure 3D: KNPLT1D Sample Output

```
PLOT 3 VGO'S
     START#150510   DURATION=   300     PASS= 1      HTKM=   0

  HEADING     75 POINTS USED

   JW-LWC     75 POINTS USED

     TEMP     75 POINTS USED

 DEWPOINT     75 POINTS USED

PRESSURE-K    75 POINTS USED

    ACCEL     75 POINTS USED
```

PLOT 4 DENSITY SPECTRA CLOUD PROBE
START=130500 STOP=151300

MIN	MAX
1	10
10	20
21	50
51	100
101	300
300	1000

LIMITS 1 152 POINTS USED

CLASS	POINTS	DIAM (MM)	CUM PCT MASS	INSTRUMENT LOG(AVE N)	EXPONENTIAL LOG (AVE N)	INSTRUMENT M (MG/M**3)	EXPONENTIAL M (MG/M**3)	INSTRUMENT Z (MM**6/M**3)	EXPONENTIAL Z(MM**6/M**3)
1	12	.023	.006	5.29023	5.12267	2.591E-02	1.752E-02	6.341E-07	4.311E-07
2	21	.047	.022	4.94831	5.00734	7.477E-02	8.501E-02	1.145E-05	1.309E-05
3	14	.067	.035	4.35174	4.89201	5.827E-02	2.022E-01	2.783E-05	9.654E-05
4	7	.093	.044	3.82566	4.77668	3.939E-02	3.519E-01	4.271E-05	3.815E-04
5	7	.133	.055	3.65617	4.56135	5.037E-02	5.134E-01	1.051E-04	1.059E-03
6	11	.133	.080	3.83884	4.34601	1.374E-01	6.684E-01	4.811E-04	2.341E-03
7	7	.142	.106	3.45192	4.43066	9.042E-02	8.036E-01	4.966E-04	4.413E-03
8	9	.162	.137	3.43505	4.31535	1.378E-01	9.111E-01	1.119E-03	7.398E-03
9	10	.132	.263	3.45971	4.20002	5.678E-01	9.873E-01	6.515E-03	1.133E-02
10	24	.202	.493	4.09467	4.08469	1.032E+00	1.032E+00	1.615E-02	1.615E-02
11	5	.221	.574	3.51064	3.96936	7.646E-01	1.048E+00	7.557E-03	2.173E-02
12	5	.241	.647	3.35223	3.85403	7.274E-01	1.040E+00	8.775E-03	2.786E-02
13	6	.261	.772	3.48261	3.73870	5.600E-01	1.010E+00	1.902E-02	3.429E-02
14	2	.281	.831	3.06352	3.62337	2.657E-01	9.643E-01	1.123E-02	4.078E-02
15	4	.301	1.000	3.43147	3.50804	7.605E-01	9.071E-01	3.945E-02	4.706E-02
SUMMATION						4.493E+00	1.054E+01	1.110E-01	2.149E-01

BEST FIT EQUATION (15 CLASSES) N/M**3-MM = N0*EXP**(LAMBDA*D): N0= 1.815E+05 LAMBDA= -13.41203 SLOPE= -5.02 INTERCEPT= 5.26

MTT= 1.752E+01 ZTT= 1.674E+00 NTT= 1.129E+04
MI(T)/MTT= 9.543E-01 ZI(T)/ZTT= 6.629E-02 D0= .274
ME(T)/MTT= 8.932E-01 ZE(T)/ZTT= 1.284E-01 MAX COUNT= 24 2 CLASSES WITH 80 PERCENT MINIMUM(1)

LIMITS 2 14 POINTS USED

CLASS	POINTS	DIAM (MM)	CUM PCT MASS	INSTRUMENT LOG(AVE N)	EXPONENTIAL LOG (AVE N)	INSTRUMENT M (MG/M**3)	EXPONENTIAL M (MG/M**3)	INSTRUMENT Z (MM**6/M**3)	EXPONENTIAL Z(MM**6/M**3)
1	0	.023	0.000		4.60083	0.	5.298E-03	0.	1.297E-07
2	1	.047	.005	4.61356	4.54966	3.437E-02	2.953E-02	5.266E-06	4.563E-06
3	0	.067	.005		4.49848	0.	9.159E-02	0.	3.901E-05
4	0	.047	.005		4.44731	0.	1.648E-01	0.	1.787E-04
5	1	.107	.032	4.13329	4.39613	1.747E-01	2.738E-01	3.604E-04	5.750E-04
6	2	.127	.055	4.06290	4.34495	2.137E-01	4.207E-01	7.696E-04	1.473E-03
7	2	.147	.103	4.25100	4.29378	5.425E-01	5.853E-01	2.979E-03	3.220E-03

Figure 3E: KNPLTID Sample Output pg 11

SUMMATION				6.631E+00	1.337E+01	1.849E-01	3.687E-01

BEST FIT EQUATION N/M**3-MM = N0*EXP**(LAMBDA*D): N0= 4.585E+04 SLOPE= -2.58
(10 CLASSES) LAMBDA= -5.95138 INTERCEPT= 4.66
MTT= 1.142E+02 ZTT= 1.248E-02 NTT= 7.109E+03
MI(T)/MTT= 5.776E-02 ZI(T)/ZTT= 1.481E-03 D0= .617
ME(T)/MTT= 1.153E+01 ZE(T)/ZTT= 2.954E-03 MAX COUNT= 2 10 CLASSES WITH 80 PERCENT MINIMUM(1)

LIMITS 3 2 POINTS USED

CLASS	POINTS	DIAM (MM)	CUM PCT MASS	INSTRUMENT LOG(AVE N)	EXPONENTIAL LOG (AVE N)	INSTRUMENT M (MG/M**3)	EXPONENTIAL M (MG/M**3)	INSTRUMENT Z (MM**6/M**	EXPONENTIAL Z(MM**6/M**3)
1	0	.023	1.000		5.54771	0.	4.688E-02	0.	1.147E-06
2	1	.043	.158	5.39165	5.39171	2.060E-01	2.060E-01	3.171E-05	3.172E-05
3	0	.063	.158		5.23571	0.	4.451E-01	0.	2.130E-04
4	0	.083	.158		5.07971	0.	7.171E-01	0.	7.666E-04
5	0	.103	.158		4.92371	0.	9.393E-01	0.	1.938E-03
6	0	.122	.158		4.76771	0.	1.114E+00	0.	3.900E-03
7	0	.142	.158		4.61171	0.	1.213E+00	0.	6.666E-03
8	0	.162	.158		4.45571	0.	1.253E+00	0.	1.022E-02
9	0	.182	.158		4.29972	0.	1.242E+00	0.	1.425E-02
10	0	.202	.158		4.14372	0.	1.183E+00	0.	1.851E-02
11	1	.221	1.000	3.96769	3.98772	1.034E+00	1.034E+00	2.267E-02	2.267E-02
12	0	.241	1.000		3.83172	0.	9.374E-01	0.	2.646E-02
13	0	.261	1.000		3.67572	0.	8.736E-01	0.	2.966E-02
14	0	.281	1.000		3.51972	0.	7.586E-01	0.	3.212E-02
15	0	.301	1.000		3.36372	0.	6.507E-01	0.	3.375E-02
SUMMATION						1.300E+00	1.273E+01	2.270E-02	2.012E-01

BEST FIT EQUATION N/M**3-MM = N0*EXP**(LAMBDA*D): N0= 5.396E+05 SLOPE= -7.88
(2 CLASSES) LAMBDA= -18.14152 INTERCEPT= 5.73
MTT= 1.556E+01 ZTT= 6.007E-01 NTT= 2.328E+04
MI(T)/MTT= 8.395E-02 ZI(T)/ZTT= 3.773E-02 D0= .202
ME(T)/MTT= 8.137E-01 ZE(T)/ZTT= 3.349E-01 MAX COUNT= 1 2 CLASSES WITH 80 PERCENT MINIMUM(1)

Figure 3F: KNPLTLD $sample Output

PLOT 6: MEDIAN VOLUME DIAMETER
START=150300 STOP=151700 PASS= 1 ATKM= 0 MINIMUM LWC= 1.000E-10 GRAMS MAXIMUM LWC= 1.000E+10 GRAMS

DO V Z/M PRECIP 90 POINTS USED

LEAST SQUARE FIT Y = (-1.0337E+00)X + (-9.1014E-02)

Y = (8.1093E-01)X** (1.0337E+00)

X LOG MEAN= -.055(8.8135E-01) Y LOG MEAN= -.148(7.1141E-01)
X LOG STD = .176(1.4323E+00) Y LOG STD = .187(1.5247E+00)

D1 V K PRECIP 90 POINTS USED

LEAST SQUARE FIT Y = (-6.5911E-01)X + (-2.0033E+00)

Y = (-9.7745E-03)X** (-6.5911E-01)

X LOG MEAN= -2.653(1.7722E-03) Y LOG MEAN= -.123(7.5259E-01)
X LOG STD = .341(2.2178E+00) Y LOG STD = .142(1.3864E+00)

MOD1 V DDP PRECIP

BAND	SAMPLES (ZEROS)	D/DD FROM - TO	MID		Y=N*DD**4/M AVE Y	LOG(AVE Y)
1	0 (0)	.050	.100	.075	1 0.	-50.00000
2	0 (0)	.100	.200	.150	1 0.	-50.00000
3	0 (0)	.200	.300	.250	1 0.	-50.00000
4	0 (0)	.400	.600	.400	1 0.	-50.00000
5	0 (0)	.600	.700	.600	1 0.	-50.00000
6	0 (0)	.700	.900	.800	1 0.	-50.00000
7	0 (0)	.900	1.100	1.000	1 0.	-50.00000
8	0 (0)	1.100	1.300	1.200	1 0.	-50.00000
9	0 (0)	1.300	1.500	1.400	1 0.	-50.00000

Figure 3G: KNPLTLD $ample Output

11	0	(0)	1.700	1.800	1.800	1	0.	-50.00000
12	0	(0)	1.800	2.100	2.000	1	0.	-50.00000
13	0	(0)	2.100	2.300	2.200	1	0.	-50.00000
14	0	(0)	2.300	2.500	2.400	1	0.	-50.00000
15	0	(0)	2.500	2.700	2.600	1	0.	-50.00000
16	0	(0)	2.700	2.800	2.800	1	0.	-50.00000
17	0	(0)	2.800	3.100	3.000	1	0.	-50.00000
18	0	(0)	3.100	3.300	3.200	1	0.	-50.00000
19	0	(0)	3.300	3.500	3.400	1	0.	-50.00000
20	0	(0)	3.500	3.700	3.600	1	0.	-50.00000
21	0	(0)	3.700	3.900	3.800	1	0.	-50.00000

0 SAMPLES USED
0 SAMPLES IGNORED

1= UNCOUNTED ZERO
2= COUNTED ZERO

Figure 3H: KNPLTLD Sample Output

71

BAND	SAMPLES (ZEROS)		D/DO FROM - TO		MID	Y=N*D.O**4/M AVE Y		LOG(AVE Y)
1	0	(0)	.050	.100	.075	1	0.	-50.00000
2	0	(0)	.100	.200	.150	1	0.	-50.00000
3	0	(0)	.200	.300	.250	1	0.	-50.00000
4	0	(0)	.300	.500	.400	1	0.	-50.00000
5	0	(0)	.500	.700	.600	1	0.	-50.00000
6	0	(0)	.700	.900	.800	1	0.	-50.00000
7	0	(0)	.900	1.100	1.000	1	0.	-50.00000
8	0	(0)	1.100	1.300	1.200	1	0.	-50.00000
9	0	(0)	1.300	1.500	1.400	1	0.	-50.00000
10	0	(0)	1.500	1.700	1.600	1	0.	-50.00000
11	0	(0)	1.700	1.800	1.800	1	0.	-50.00000
12	0	(0)	1.800	2.100	2.000	1	0.	-50.00000
13	0	(0)	2.100	2.300	2.200	1	0.	-50.00000
14	0	(0)	2.300	2.500	2.400	1	0.	-50.00000
15	0	(0)	2.500	2.700	2.600	1	0.	-50.00000
16	0	(0)	2.700	2.800	2.800	1	0.	-50.00000
17	0	(0)	2.800	3.100	3.000	1	0.	-50.00000
18	0	(0)	3.100	3.300	3.200	1	0.	-50.00000
19	0	(0)	3.300	3.500	3.400	1	0.	-50.00000
20	0	(0)	3.500	3.700	3.600	1	0.	-50.00000
21	0	(0)	3.700	3.900	3.800	1	0.	-50.00000

0 SAMPLES USED
0 SAMPLES IGNORED

1= UNCOUNTED ZERO
2= COUNTED ZERO

TOTAL 42 BOTHS USED

```
LEAST SQUARE FIT          Y = ( 1.0001E+00)X + (-1.0961E-01)

                          Y = ( 6.4683E-01)X** ( 1.0631E+00)

X LOG MEAN=  -.155(7.0718E-01)                      Y LOG MEAN=  -.355(4.4203E-01)
X LOG STD =   .236(1.7134E+00)                      Y LOG STD =   .312(2.0489E+00)

----------------------------------------------------------------------------------------

   OD V K        TOTAL     87 POINTS USED

LEAST SQUARE FIT          Y = (-9.9116E-01)X + (-2.3906E+00)

                          Y = ( 1.0219E-03)X** (-9.9116E-01)

X LOG MEAN= -2.613(2.4369E-03)                      Y LOG MEAN=  -.401(3.9762E-01)
X LOG STD =   .371(1.3673E+00)                      Y LOG STD =   .311(2.0475E+00)

----------------------------------------------------------------------------------------

NO31 V OD0       TOTAL
AT *15:06:01*              D/00=   4.01252      CHANNEL 10 IGNORED
AT *15:06:01*              D/00=   4.40660      CHANNEL 11 IGNORED
AT *15:06:01*              D/00=   4.80069      CHANNEL 12 IGNORED
AT *15:06:01*              D/00=   5.19478      CHANNEL 13 IGNORED
AT *15:06:01*              D/00=   5.56336      CHANNEL 14 IGNORED
AT *15:06:01*              D/00=   5.96295      CHANNEL 15 IGNORED
AT *15:06:05*              D/00=    .03221      CHANNEL  1 IGNORED
AT *15:06:05*              D/00=   4.16257      CHANNEL 10 IGNORED
AT *15:06:05*              D/00=   4.57140      CHANNEL 11 IGNORED
AT *15:06:05*              D/00=   4.98022      CHANNEL 12 IGNORED
AT *15:06:05*              D/00=   5.38905      CHANNEL 13 IGNORED
AT *15:06:05*              D/00=   5.79737      CHANNEL 14 IGNORED
AT *15:06:05*              D/00=   6.20669      CHANNEL 15 IGNORED
AT *15:06:09*              D/00=   5.13336      CHANNEL  3 IGNORED
AT *15:06:09*              D/00=   6.74736      CHANNEL  4 IGNORED
AT *15:06:09*              D/00=   8.36036      CHANNEL  5 IGNORED
AT *15:06:09*              D/00=   9.97436      CHANNEL  6 IGNORED
AT *15:06:09*              D/00=  11.58736      CHANNEL  7 IGNORED
AT *15:06:09*              D/00=  13.20136      CHANNEL  8 IGNORED
AT *15:06:09*              D/00=  14.81436      CHANNEL  9 IGNORED
AT *15:06:09*              D/00=  16.42836      CHANNEL 10 IGNORED
AT *15:06:09*              D/00=  18.04136      CHANNEL 11 IGNORED
AT *15:06:09*              D/00=  19.65536      CHANNEL 12 IGNORED
AT *15:06:09*              D/00=  21.26836      CHANNEL 13 IGNORED
AT *15:06:09*              D/00=  22.88236      CHANNEL 14 IGNORED
AT *15:06:09*              D/00=  24.49536      CHANNEL 15 IGNORED
AT *15:06:41*              D/00=   4.16152      CHANNEL 11 IGNORED
AT *15:06:41*              D/00=   4.55547      CHANNEL 12 IGNORED
AT *15:06:41*              D/00=   4.92943      CHANNEL 13 IGNORED
AT *15:06:41*              D/00=   5.30339      CHANNEL 14 IGNORED
AT *15:06:41*              D/00=   5.67734      CHANNEL 15 IGNORED
AT *15:06:4?*              D/00=   4.26827      CHANNEL  9 IGNORED
```


Figure 3I: KNPLT1D Sample Output

```
AT *15:12:41*          D/DD=    8.70775     CHANNEL  6 IGNORED
AT *15:12:41*          D/DD=   10.11635     CHANNEL  7 IGNORED
AT *15:12:41*          D/DD=   11.52496     CHANNEL  8 IGNORED
AT *15:12:41*          D/DD=   12.93357     CHANNEL  9 IGNORED
AT *15:12:41*          D/DD=   14.34217     CHANNEL 10 IGNORED
AT *15:12:41*          D/DD=   15.75078     CHANNEL 11 IGNORED
AT *15:12:41*          D/DD=   17.15939     CHANNEL 12 IGNORED
AT *15:12:41*          D/DD=   18.56799     CHANNEL 13 IGNORED
AT *15:12:41*          D/DD=   19.97660     CHANNEL 14 IGNORED
AT *15:12:41*          D/DD=   21.38520     CHANNEL 15 IGNORED
AT *15:12:45*          D/DD=    5.20015     CHANNEL  3 IGNORED
AT *15:12:45*          D/DD=    6.63435     CHANNEL  4 IGNORED
AT *15:12:45*          D/DD=    8.46865     CHANNEL  5 IGNORED
AT *15:12:45*          D/DD=   10.10245     CHANNEL  6 IGNORED
AT *15:12:45*          D/DD=   11.73726     CHANNEL  7 IGNORED
AT *15:12:45*          D/DD=   13.37156     CHANNEL  8 IGNORED
AT *15:12:45*          D/DD=   15.00586     CHANNEL  9 IGNORED
AT *15:12:45*          D/DD=   16.64016     CHANNEL 10 IGNORED
AT *15:12:45*          D/DD=   18.27446     CHANNEL 11 IGNORED
AT *15:12:45*          D/DD=   19.90876     CHANNEL 12 IGNORED
AT *15:12:45*          D/DD=   21.54306     CHANNEL 13 IGNORED
AT *15:12:45*          D/DD=   23.17737     CHANNEL 14 IGNORED
AT *15:12:45*          D/DD=   24.81167     CHANNEL 15 IGNORED
AT *15:12:49*          D/DD=    .01304      CHANNEL  1 IGNORED
AT *15:12:49*          D/DD=    .02407      CHANNEL  2 IGNORED
AT *15:12:53*          D/DD=    .02642      CHANNEL  1 IGNORED
AT *15:12:57*          D/DD=    .04878      CHANNEL  2 IGNORED
AT *15:12:53*          D/DD=   4.08559      CHANNEL 12 IGNORED
AT *15:12:57*          D/DD=   4.42109      CHANNEL 13 IGNORED
AT *15:12:53*          D/DD=   4.75648      CHANNEL 14 IGNORED
AT *15:12:57*          D/DD=   5.09187      CHANNEL 15 IGNORED
AT *15:12:57*          D/DD=    .03259      CHANNEL  1 IGNORED
AT *15:12:57*          D/DD=   4.25071      CHANNEL 10 IGNORED
AT *15:12:57*          D/DD=   4.66819      CHANNEL 11 IGNORED
AT *15:12:57*          D/DD=   5.08567      CHANNEL 12 IGNORED
AT *15:12:57*          D/DD=   5.50316      CHANNEL 13 IGNORED
AT *15:12:57*          D/DD=   5.92064      CHANNEL 14 IGNORED
AT *15:12:57*          D/DD=   6.33812      CHANNEL 15 IGNORED

     44 NON-ZERO POINTS PLOTTED


 X LOG MEAN=    .956(7.1340E+01)                 Y LOG MEAN=  1.051(1.1244E+01)
 X LOG STD =    .794(6.2221E+00)                 Y LOG STD =  1.755(5.6948E+01)


 BAND     SAMPLES                    D/DD                          Y=L*D0**A/M
                (ZEROS)          FROM -  TO      MID          AVE Y      LOG(AVE Y)

   1          125    (109)        .000    .100    .075      1.633E+03    7.21424
   2          173    (173)        .100    .200    .150      4.043E+02    2.60672
   3          144    (113)        .200    .300    .250      1.233E+02    2.09296
   4          203    (160)        .300    .500    .400      4.156E+01    1.61867
   5           55    ( 53)        .500    .700    .600      1.472E+01    1.16501
   6           38    ( 42)        .700    .900    .800      3.055E+00     .48496
   7           51    ( 15)        .900   1.100   1.000      4.391E+00     .63357
   8           36    ( 23)       1.100   1.300   1.200      7.605E-01    -.11868
   9           31    ( 22)       1.300   1.500   1.400      4.408E-01    -.35600
  10           22    ( 20)       1.500   1.700   1.600      4.668E-01    -.38070
  11           30    ( 16)       1.700   1.900   1.800      3.011E-02   -1.52135
  12           25    ( 21)       1.900   2.100   2.000      1.808E-03   -2.74290
  13           21    ( 23)       2.100   2.300   2.200      6.688E-03   -2.17610
  14           19    ( 16)       2.300   2.500   2.400      9.448E-03   -2.00226
  15           24    ( 23)       2.500   2.700   2.600      1.297E-03   -2.90062
  16           15    ( 14)       2.700   2.900   2.800      4.496E-03   -2.30141
```

Figure 3J: KNPLT1D Sample Output

17	22	(17)	3.000	3.100	3.100		
18	18	(17)	3.100	3.300	3.200		1.821E-03 -2.73973
19	20	(17)	3.300	3.500	3.400		9.811E-04 -3.00829
20	14	(15)	3.500	3.700	3.600		6.289E-04 -3.20144
21	19	(17)	3.700	3.900	3.800	2	4.198E-04 -3.37686

1246 SAMPLES USED
654 SAMPLES IGNORED

1= UNCOUNTED ZERO
2= COUNTED ZERO

Figure 3K: KNPLTLD $sample Output

Figure 4A: KNPLT1D Sample Plots

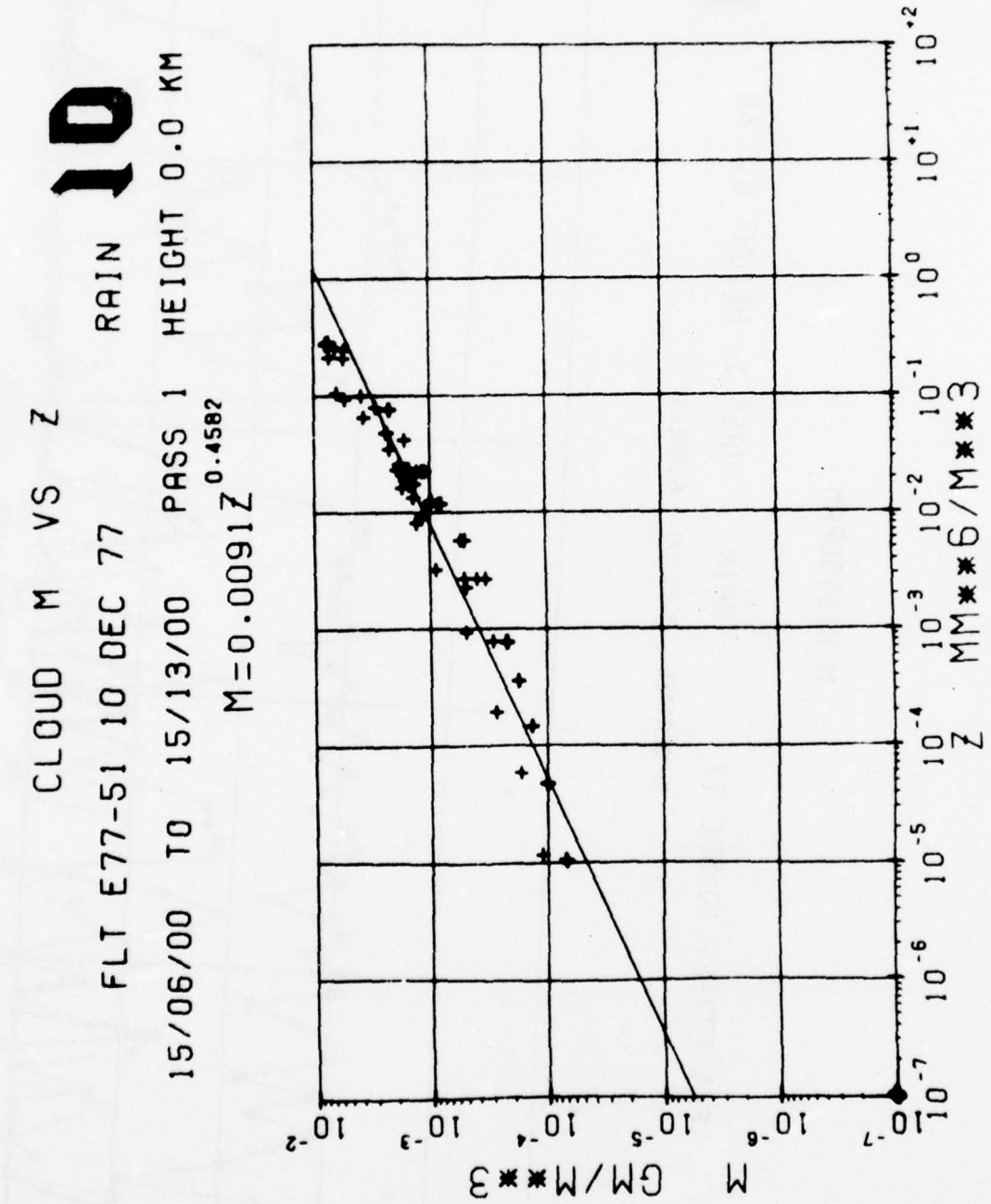


Figure 4B: KNPLT1D Sample Plots

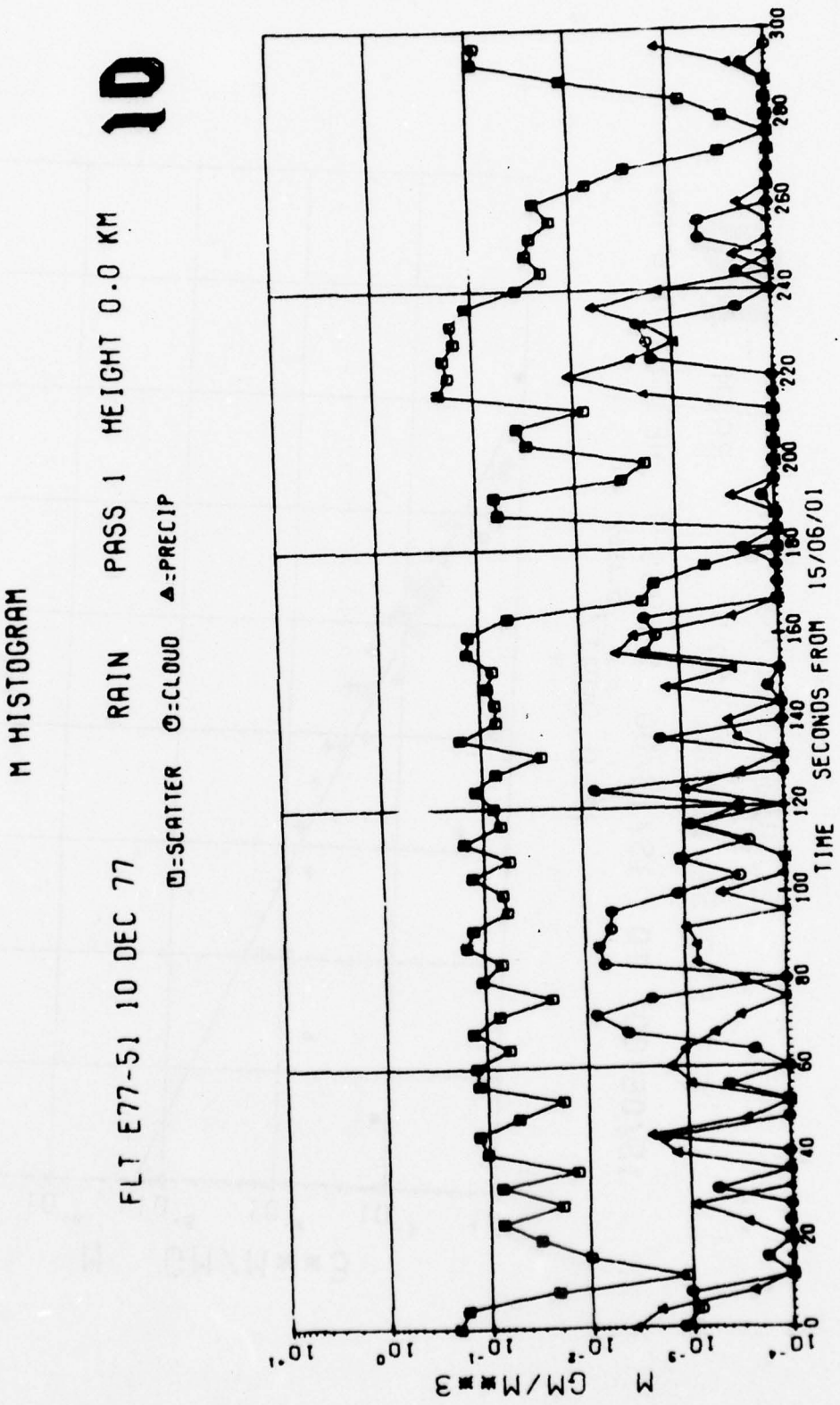


Figure 4C: KNPLT1D Sample Plots

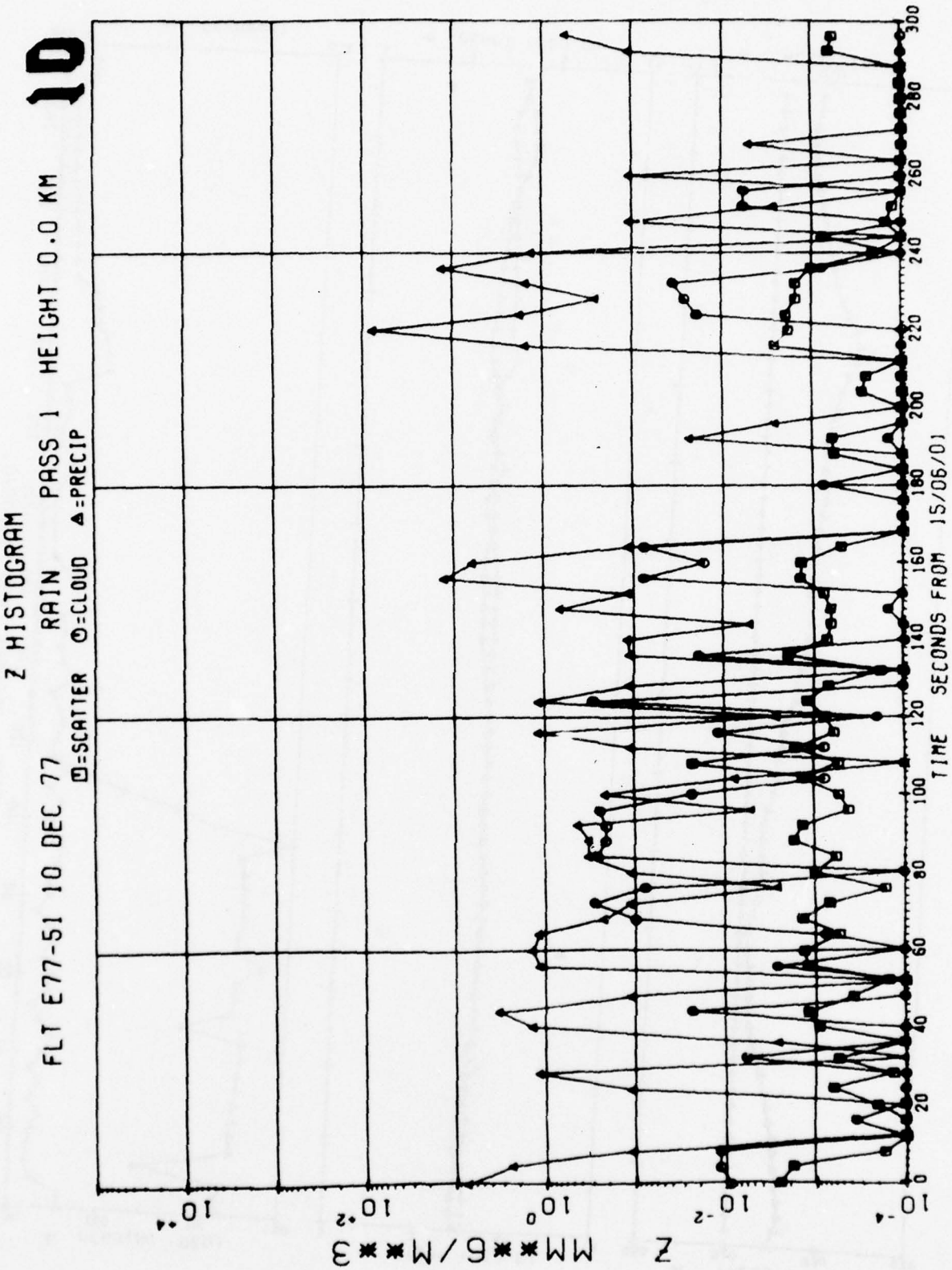


Figure 4D: KNPLT1D Sample Plots

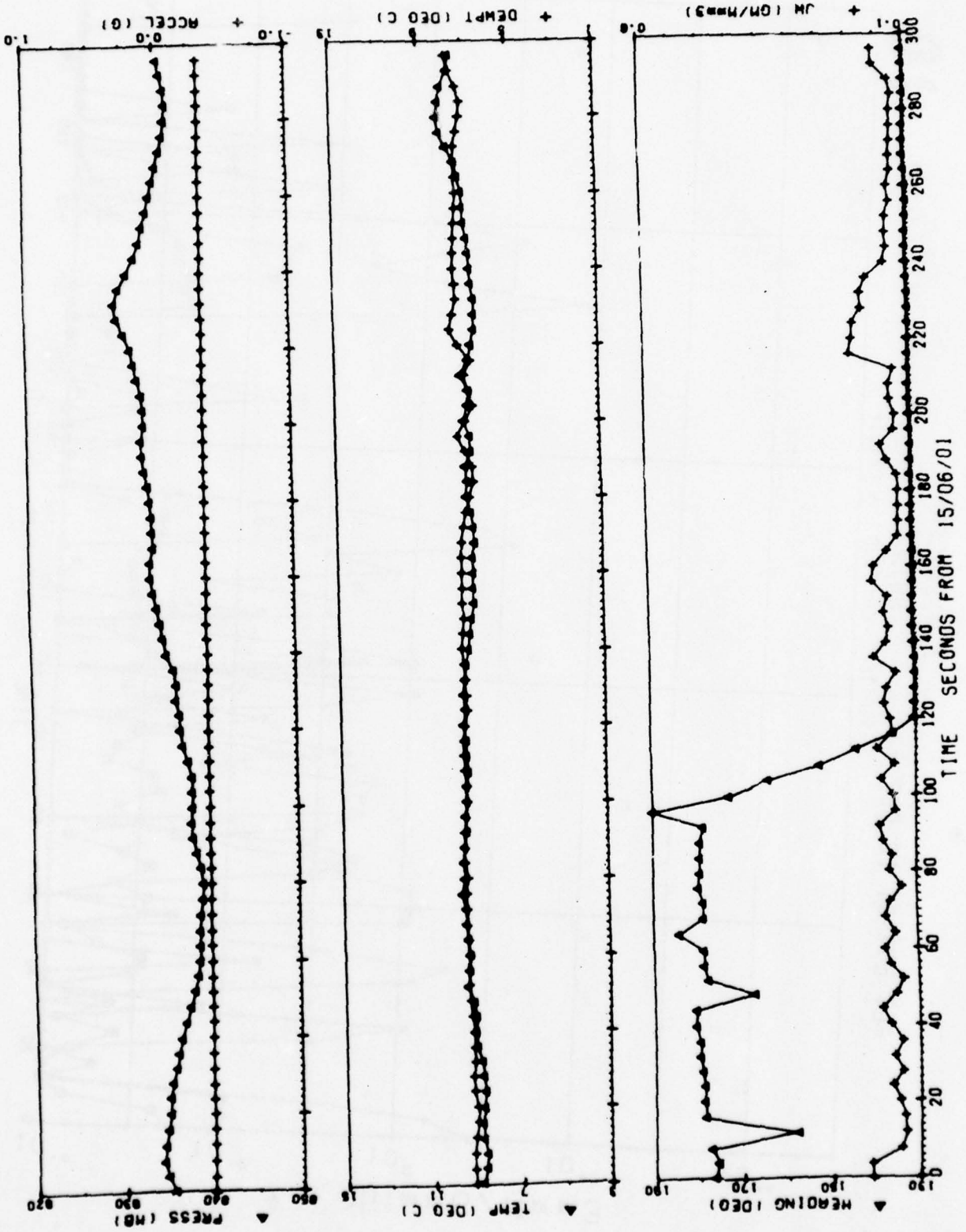


Figure 4E: KNPLT1D Sample Plots

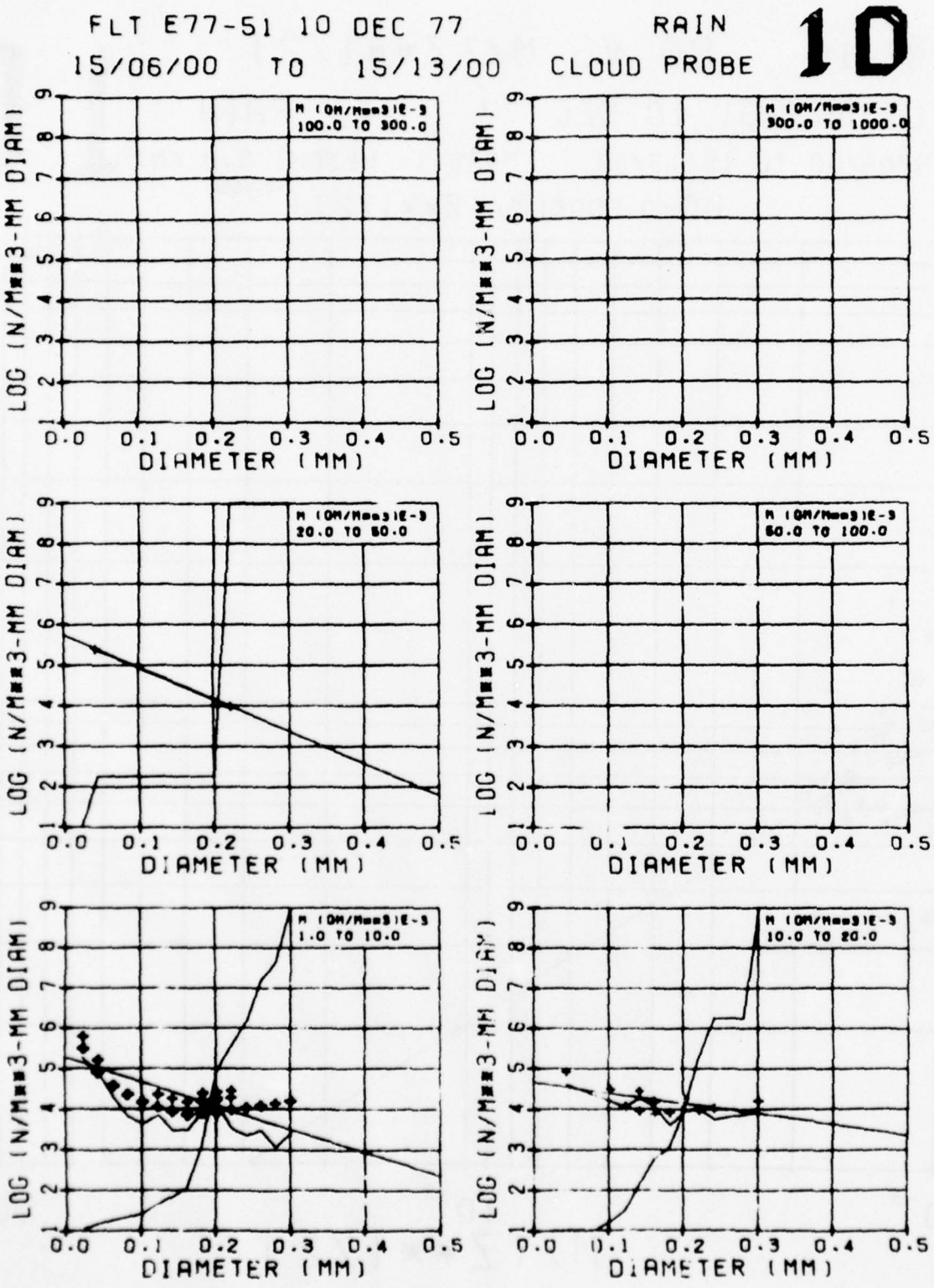


Figure 4F: KNPLT1D Sample Plots

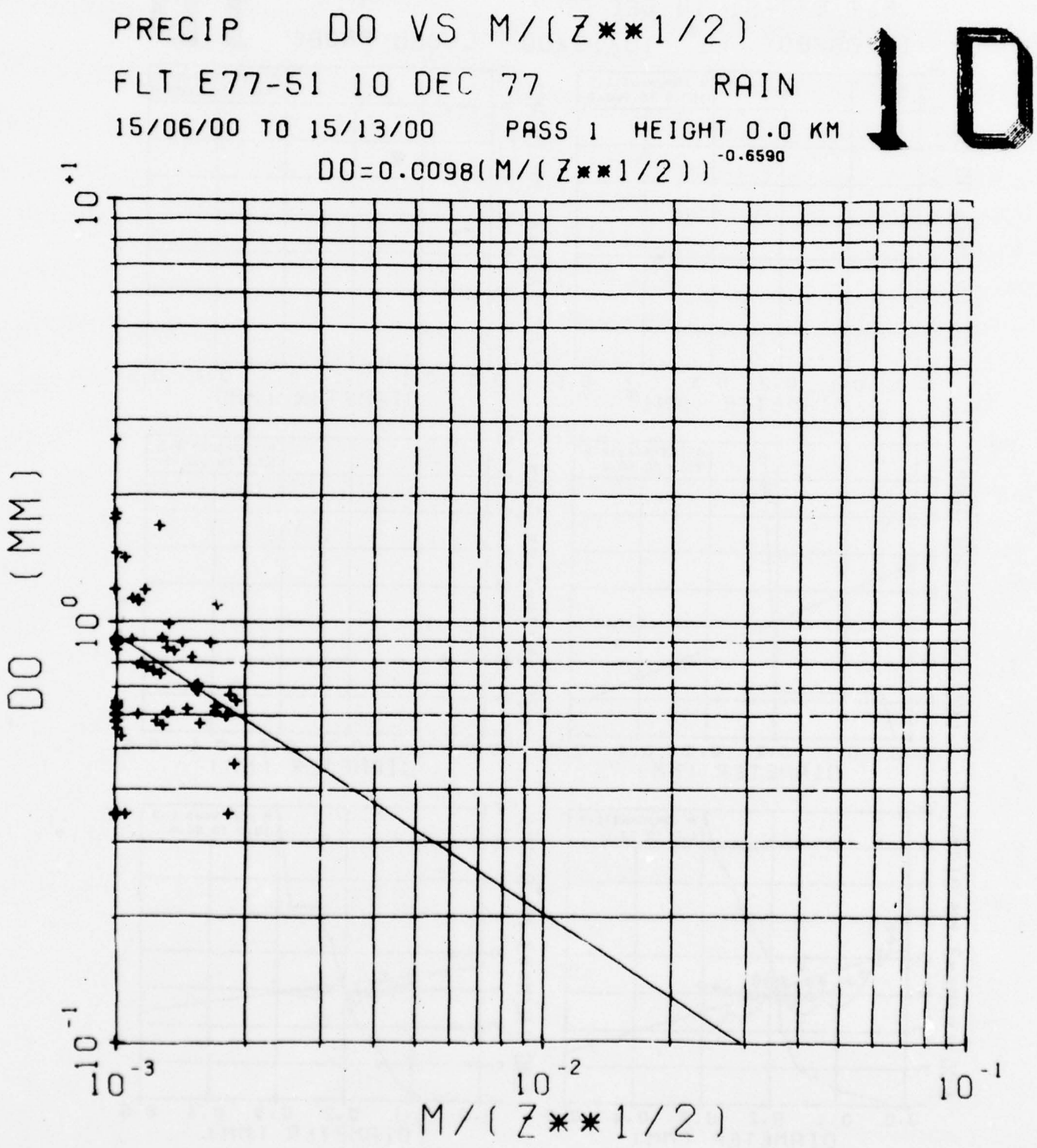


Figure 4G: KNPLT1D Sample Plots

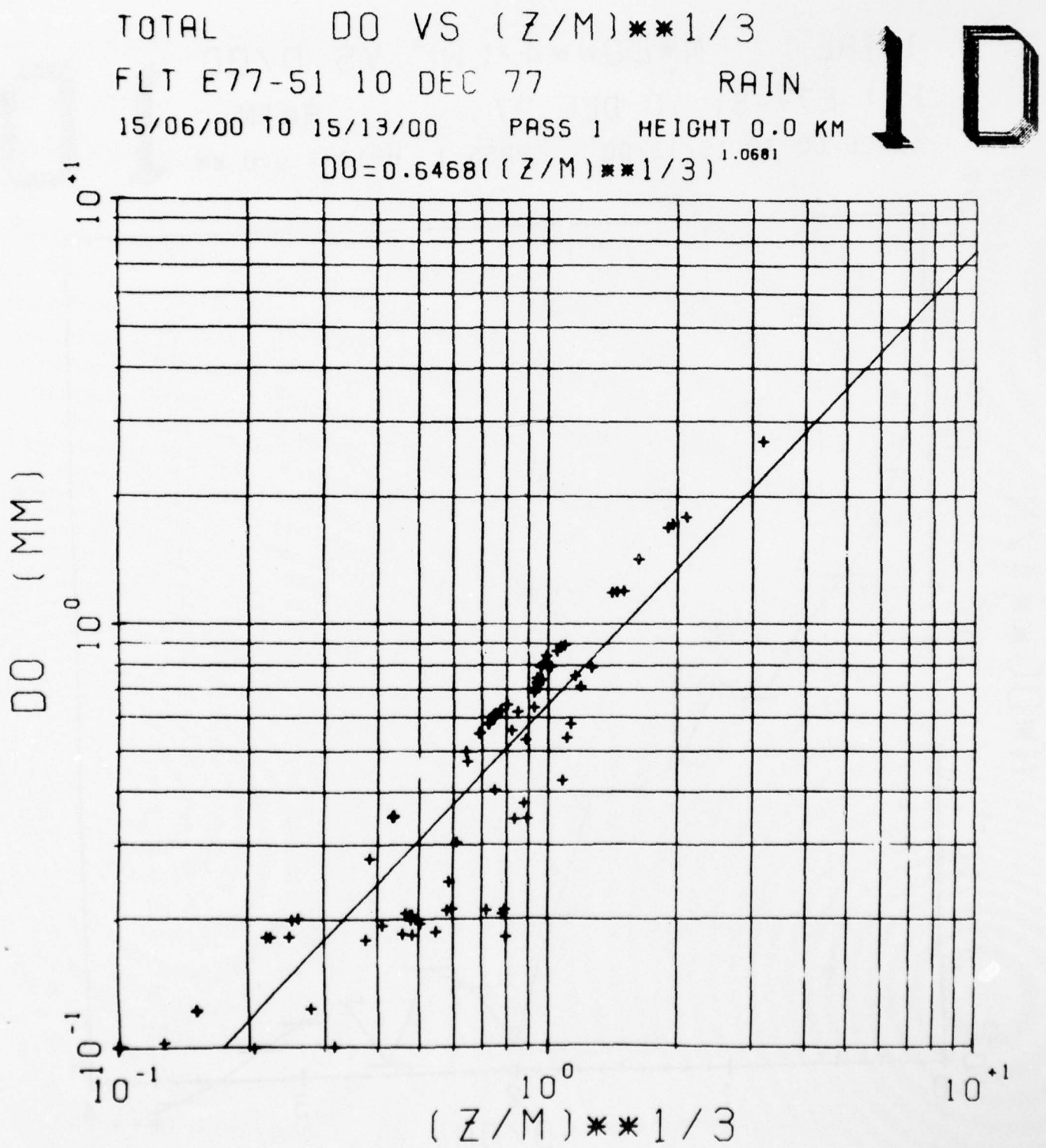


Figure 4H: KNPLT1D Sample Plots

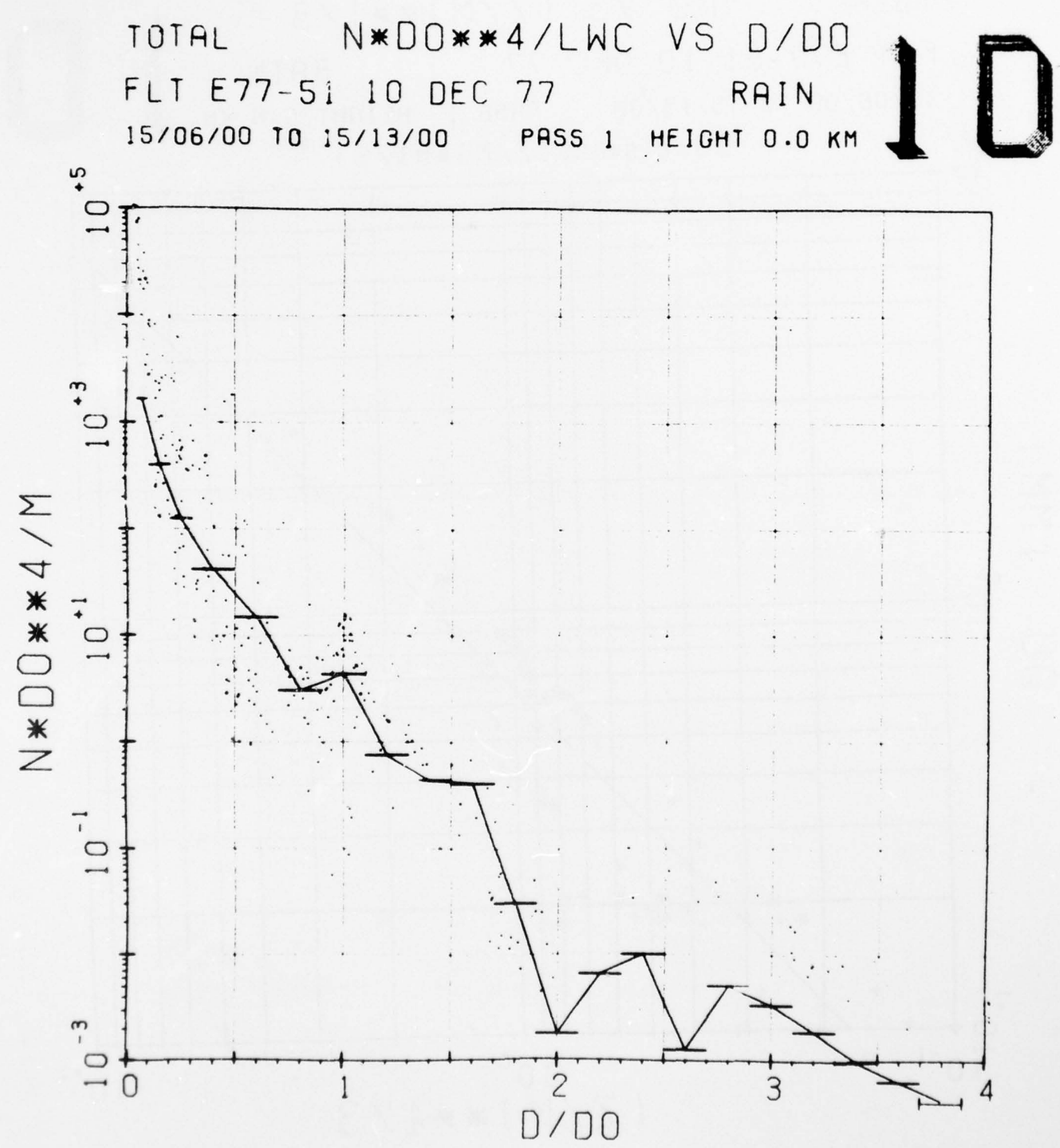


Figure 4I: KNPLT1D Sample Plots

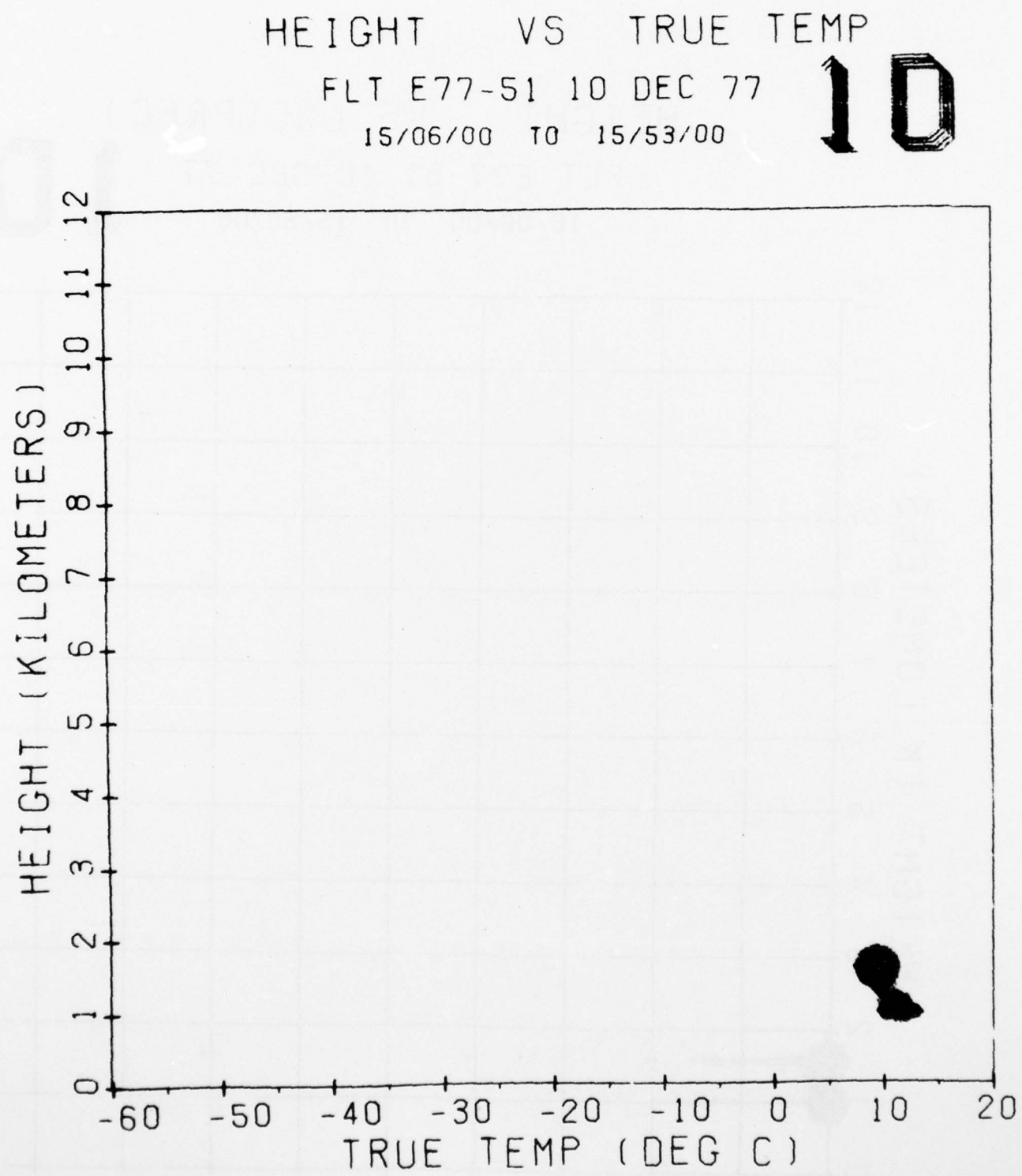
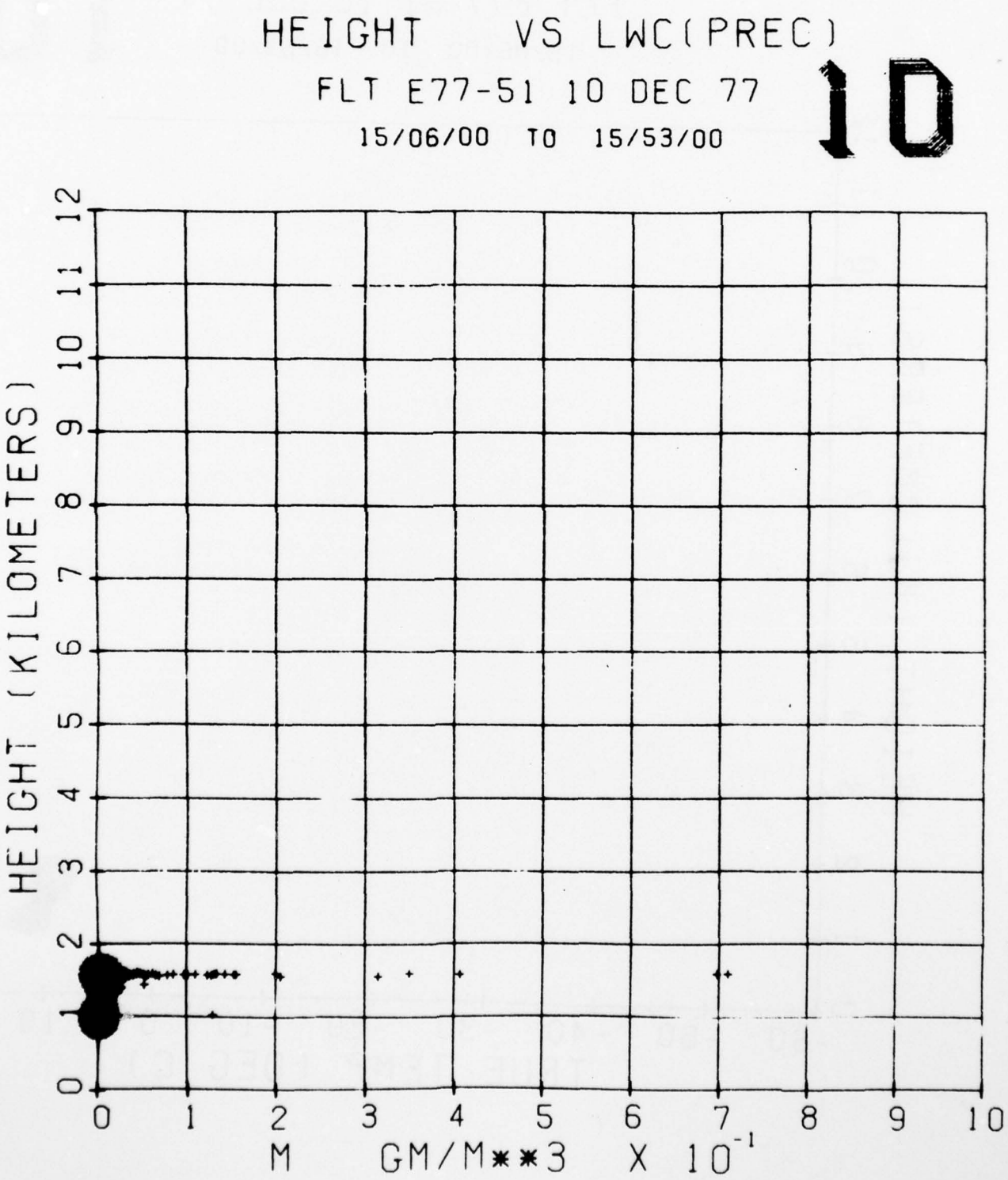


Figure 4J: KNPLT1D Sample Plots



2.4 DENPLOT

2.4.1 Program Description

DENPLOT produces graphs of the log of normalized number density vs. particle diameter measured during a given interval of time from a user specified start time. It is run from the Tektronix graphics terminal interactively.

The program uses a standard KNOLL1D (TAPE2) plot tape which has been previously cataloged onto the disk as its input tape.

2.4.2 Operating Instructions

To use DENPLOT from the Tektronix terminal, the user should execute the following commands:

```
LOGIN,NAME,PASSWORD,TTYNO↓
M, PLS MOUNT DISK LYCPFI↓
MOUNT,SN=LYCPFI,VSN=LYCPFI↓
SETNAME(LYCPFI)↓
ATTACH,TEK,TEKLIB,SN=SHARED↓
LIBRARY(TEK)↓
ATTACH,LGO,DENPLOTBIN,ID=FRANCIS↓
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME↓
CONNECT,INPUT↓
CONNECT,OUTPUT↓
LGO↓
[INPUT RESPONSES]
```

2.4.3 Input Responses

After the LGO command has been executed, the program will begin asking for various parameters:

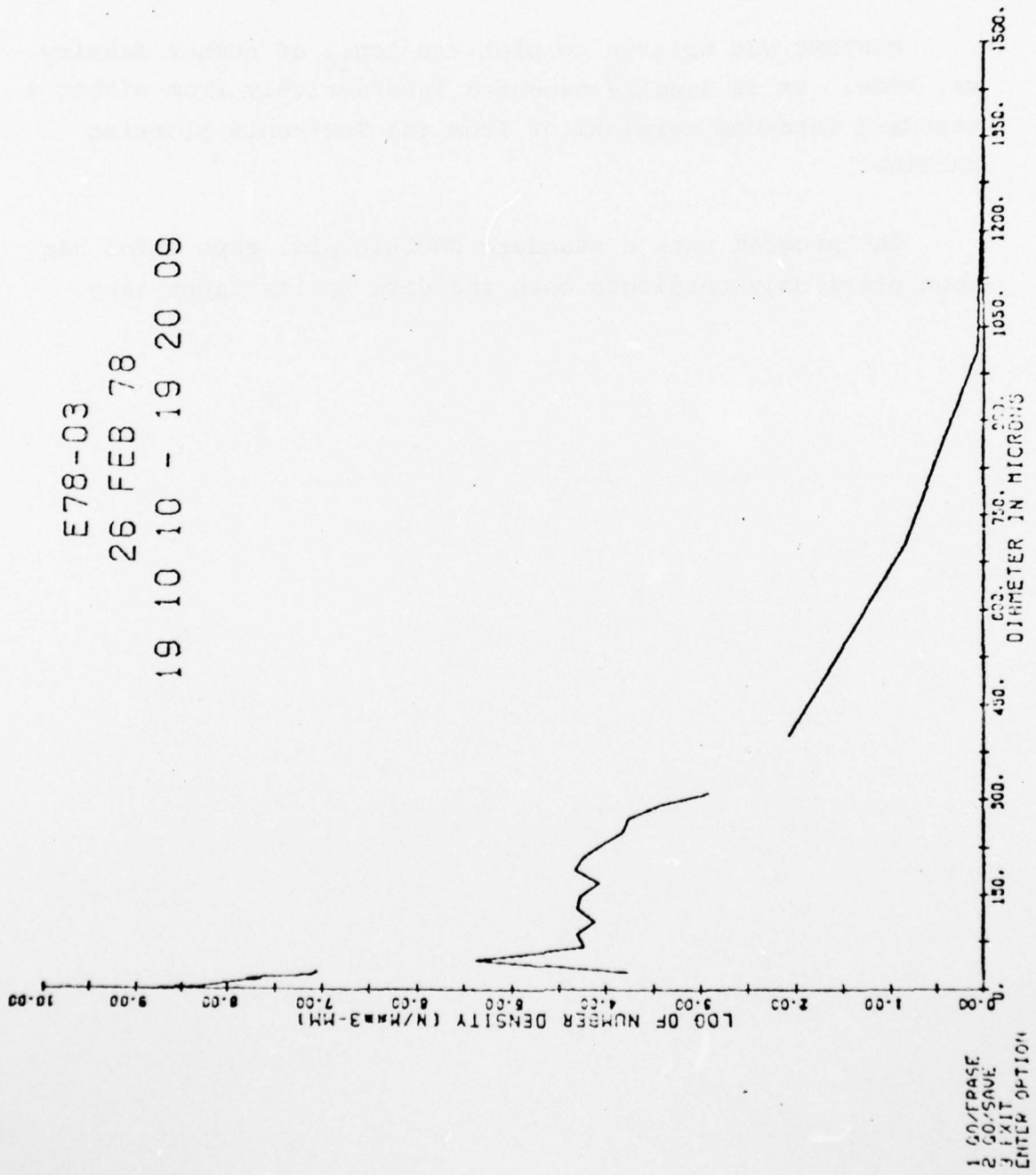
(1) The flight ID
(2) The date of the flight
(3) Which probe to begin the plot with
(4) Which probe to end the plot with
(5) The desired starting time
(6) Which clock to take the time from
(7) The number of seconds worth of data to be plotted

For example, the session in Figure 5 produces a plot of the normalized number density of all three probes. It uses 600 seconds worth of data starting at 19:10:10. It uses the PMS clock to determine the time. The flight took place on 26 February 1978 and its flight ID was E78-03. The graph produced by this session is shown in Figure 6.

Figure 5: DENPLOT Sample Session

```
LGO
FLIGHT ID..
  E78-03
DATE..
  26 FEB 78
STARTING PROBE (1-SC, 2-CL, 3-PR)..
1
ENDING PROBE..
3
START TIME HH MM SS..
19 10 10
CLOCK (A/C=1,PMS=2)..
2
LENGTH (IN SEC) OF INTERVAL TO PLOT..
600
```

Figure 6: LIDPLOT Sample Output



2.5 DENTIME

2.5.1 Program Description

DENTIME was written to plot the $\log_{10}$ of number density vs. time. It is usually executed interactively from either a standard Intercom terminal or from the Tektronix plotting terminal.

The program uses a standard KNOLLlD plot tape which has been previously cataloged onto the disk as its input tape.

2.5.2 Control Commands

In order to run DENTIME from the Tektronix plotting terminals the user must execute the following commands:

```
LOGIN,NAME,PASSWORD,TTYNO
M,PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI
SETNAME(LYCPFI)
ATTACH,LGO,DENTIMEBIN,ID=LEACH
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME
ATTACH,LIB,TEKLIB,SN=SHARED
LIBRARY(LIB)
CONNECT,INPUT
CONNECT,OUTPUT
LGO
```

In order to run DENTIME from a standard Intercom terminal, the user must execute the following commands:

```
LOGIN,NAME,PASSWORD,TTYNO
M,PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI
SETNAME(LYCPFI)
ATTACH,LGO,DENTIMEBIN,ID=LEACH
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME
ATTACH,LIB,SMALLONLINE,SN=SHARED
LIBRARY(LIB)
CONNECT,INPUT
CONNECT,OUTPUT
REQUEST,SMPLOT,*Q
LGO
[INPUT DATA]   see section 2.5.3
DISPOSE,SMPLOT,SP
```

2.5.3 Input Commands

After the LGO command is executed (at either terminal) the program will begin asking the user for various input parameters concerning the type of plot to be made.

It asks for the following parameters:

(1) type of terminal being used
(2) number of minutes to be plotted
(3) which probe type to use
(4) type of density to be plotted
(5) date of the flight
(6) maximum y-value desired
(7) which clock time
(8) starting time

2.5.4 Output Details

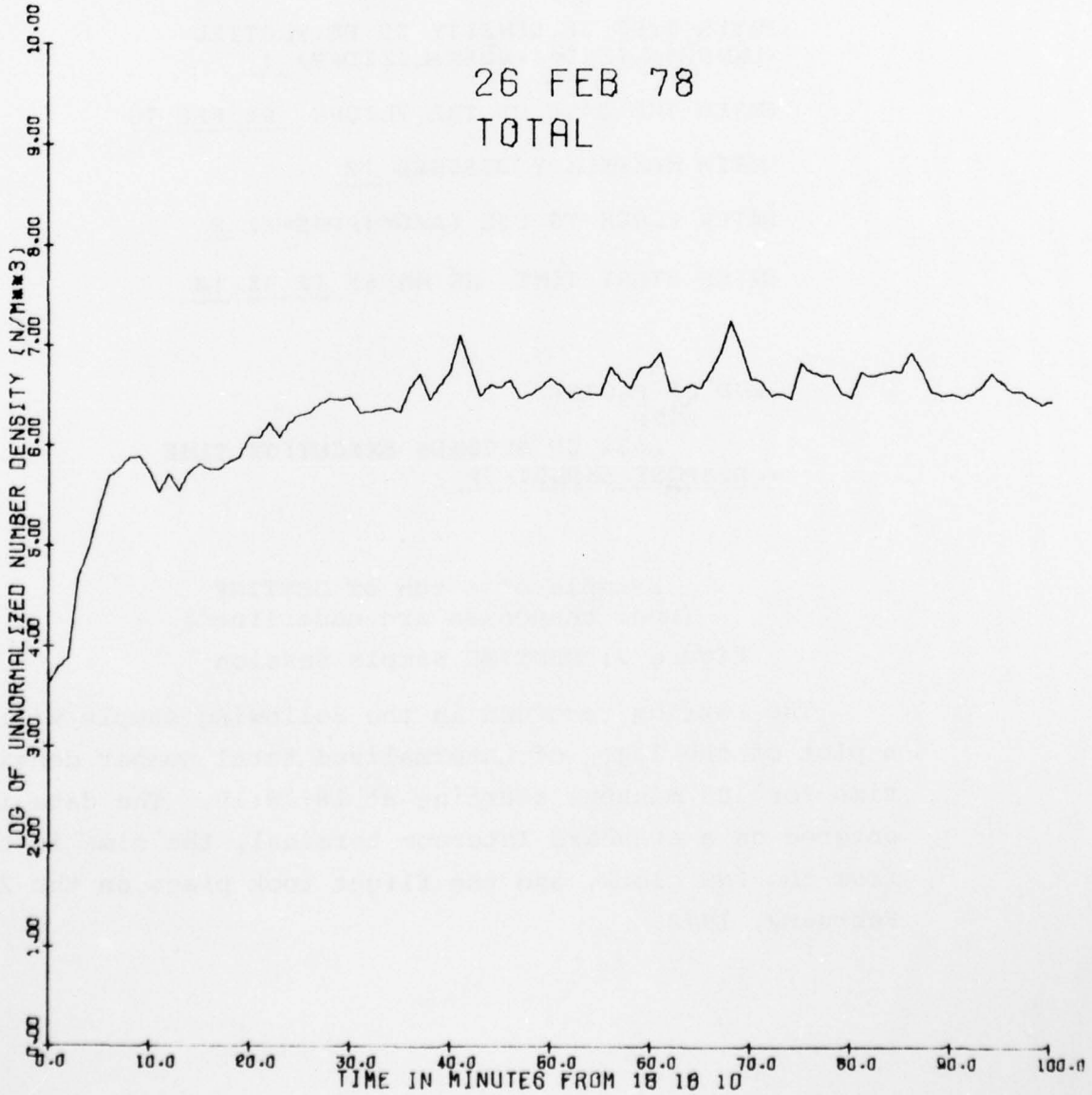
```
ENTER TYPE OF TERMINAL
(STANDARD INTERCOM=1, TEKTRONIX=2) 1

ENTER THE NUMBER OF MINUTES
TO BE PLOTTED 100

ENTER PROBE TYPE
(SCATTER=1, CLOUD=2, PRECIP=3, TOTAL=4) 4

ENTER TYPE OF DENSITY TO BE PLOTTED
(UNNORMALIZED=1, NORMALIZED=2) 1

ENTER THE DATE OF THE FLIGHT 26 FEB 78

ENTER MAXIMUM Y DESIRED 10

ENTER CLOCK TO USE (A/C=1, PMS=2) 2

ENTER START TIME  HH MM SS 18 18 10


 END OF PLOTS.
     STOP
       .634 CP SECONDS EXECUTION TIME
..DISPOSE, SMPLOT, SP
```

Example of a run of DENTIME
(user responses are underlined)

Figure 7: DENTIME Sample Session

The session recorded in the following sample will create a plot of the $\log_{10}$ of unnormalized total number density vs. time for 100 minutes starting at 18:18:10. The data is being entered on a standard Intercom terminal, the time is taken from the PMS clock, and the flight took place on the 26th of February, 1978.

Figure 8: DENTIME Sample Plot



2.6 VHPLOT

2.6.1 Program Description

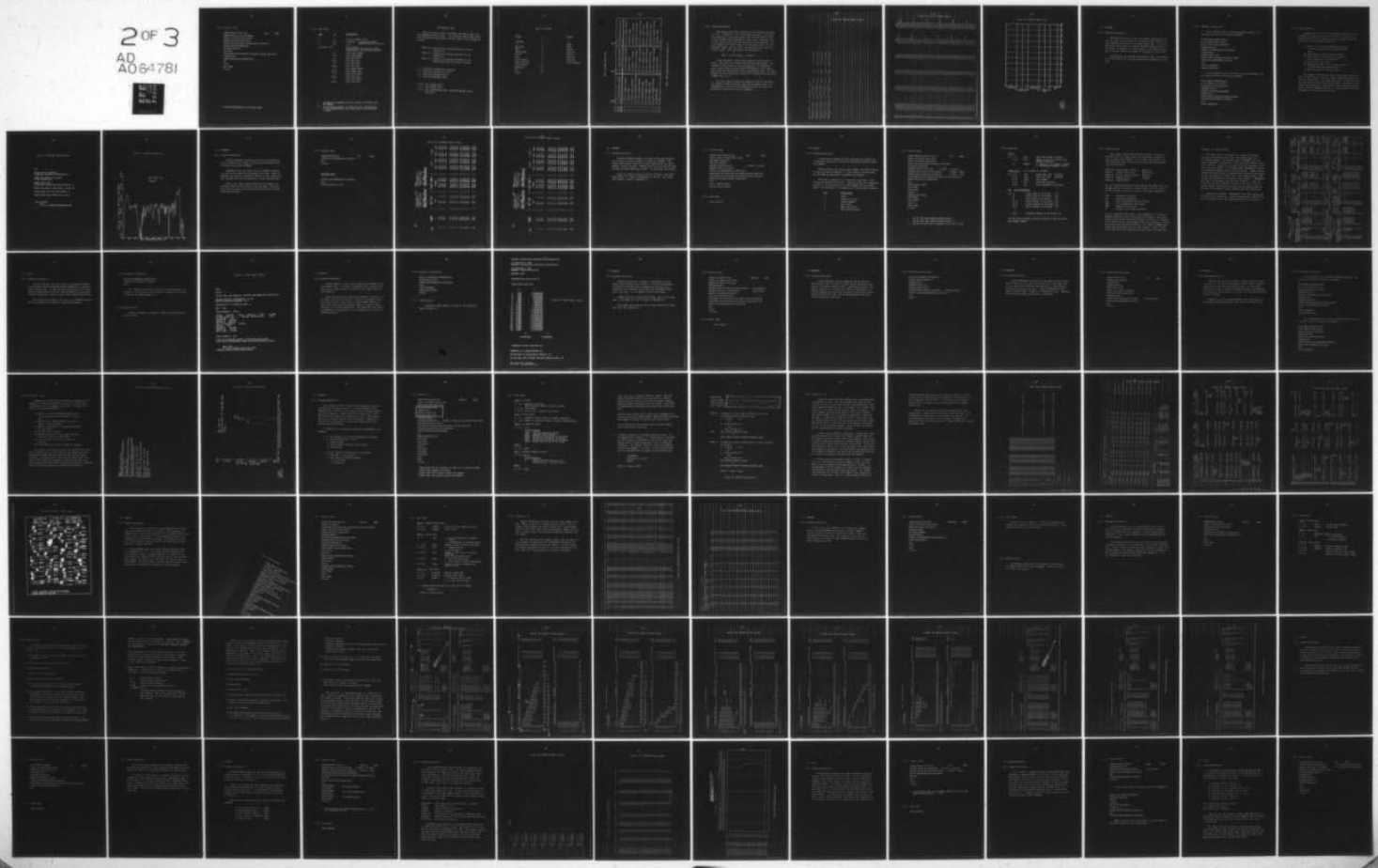
Program VHPLOT produces calibrated pen plots of reflected PMS-1D VCO and status word data as read from the Kennedy tape. Since any set of five different VCO/STATUS values can be plotted on one frame and one frame may have up to one hour's worth of data, this program may be used to visually demonstrate the error of one piece of equipment in relation to others.

Input to VHPLOT is via cards through the CDC 6600 batch processor and the input tape is the same as the one used in KNOLL1D and KN1UTIL (Appendices 1-3). Output consists of both tabulated data and CALCOMP pen plots. Plot output may also be routed to the Tektronix graphics terminal.

AD-A064 781 DIGITAL PROGRAMMING SERVICES INC WALTHAM MASS F/G 4/2
DEVELOPMENT AND APPLICATION OF MATHEMATICAL PROCEDURES TO A VAR--ETC(U)
JUN 78 L E BELSKY, M W FRANCIS, F B KAPLAN F19628-76-C-0241

UNCLASSIFIED AFGL-TR-78-0170 NL

2 OF 3
AD
A064781



2.6.2 Control C rds

```
JOBNM,CM60000,T200[1],TP1.                    ACT.      NAME
REQUEST,TAPE1,S,HI,VSN=PMSXXX.
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
ATTACH,LGO,VHPLOTBIN,ID=GLASS,MR=1,SN=LYCPFI.
ATTACH,PEN,ONLINEPEN,MR=1.
DISPOSE,PLOT,*OL.
MAP,PART.
FILE(TAPE1,RT=U,BT=K,MRL=1024,MBL=1024,RB=1,BFS=105)
LIBRARY(PEN)
LDSET,FILES=TAPE1,PRESET=ZERO.
LGO.
7/8/9
DATA CARDS
6/7/8/9
```

[1] ALLOW APPROXIMATELY 60 sec/hour/frame

2.6.3 Data Cards

CARD	cc	DESCRIPTION
1	1	aircraft model A or E
2	2-10	$ CHANGES CALIBRATION CARDS* INSERTED HERE AS REQUIRED
3	2-6	$ END
4 through (n+3)		for n frames (MAXIMUM ONE HOUR DATA PER FRAME) (CARDS MAY BE IN ANY TIME SEQUENCE)
	1-6	START TIME HHMMSS
	8-13	STOP TIME HHMMSS
	25	PLOT ONE TYPE**
	29-30	PLOT ONE CODE
	35	PLOT TWO TYPE**
	39-40	PLOT TWO CODE
	45	PLOT THREE TYPE**
	49-50	PLOT THREE CODE
	55	PLOT FOUR TYPE**
	59-60	PLOT FOUR CODE
	65	PLOT FIVE TYPE**
	69-70	PLOT FIVE CODE

* CALIBRATION CONSTANTS AND AXIS LIMITS (IN COUNTS) CAN BE CHANGED

** TYPE SPECIFIES WHETHER A PLOT WILL BE V (FOR VCO) OR H (FOR HOUSEKEEPING), THE CODES ARE ON THE FOLLOWING 3 PAGES

CALIBRATION CARDS

There are three control variables that may be used with the $CHANGES namelist input. The variables shown below allow the calibration coefficients and axis limits to be changed as needed.

VCOA(I,J) controls any changes pertinent to the C130A VCO's

VCOE(I,J) controls any changes pertinent to the C130E VCO's

HSVL(I,J) controls any changes pertinent to the housekeeping data for either aircraft

I = 1 specifies calibration intercept
= 2 specifies calibration slope
= 3 specifies minimum counts
= 4 specifies maximum counts

J = 1-13 for A model VCO's
= 1-9 for E model VCO's
= 1-30 for housekeeping data - from the PMS-1D status word code

PMS 1D VCO CODE

C130A	J	C130E
Pressure	1	Δ P
Δ P	2	Temp
Mag Head	3	EWER
Temp	4	UNUSED
Event/Cloud	5	Dewp/1011
LWC/JW	6	LWC/JW
Rain	7	Mag Head
Tacan Bearing	8	Pressure
Tacan Distance	9	true airspeed
Acceleration	10	
Dewp/1011	11	
Ice	12	
Pitch	13	

PMS 1D STATUS WORD CODE

msec	CODE J	scatter probe status	CODE J	cloud probe status	CODE J	precip probe status
0	1	+15v. supply voltage	2	+15v. supply voltage	3	+15v. supply voltage
1	4	probe temp.	5	mirror temp.	6	mirror temp.
2	7	size range selected	8	element 1 voltage	9	element 1 voltage
3	10	laser reference voltage	11	element 24 voltage	12	element 24 voltage
4	13	-15v. supply voltage	14	-15v. supply voltage	15	-15v. supply voltage
5	16	electronics temp.	17	+5v. supply temp.	18	+5v. supply temp
6	19	+5v. supply voltage	20	+5v. supply voltage	21	+5v. supply voltage
7	22	+5v. supply temp.	23	electronics temp.	24	electronics temp.
8	25	+15v. supply voltage	26	+15v. supply voltage	27	+15v. supply voltage
9	28	probe temp.	29	mirror temp.	30	mirror temp.

msec = PMS elapsed second clock modulo 10

2.6.4 Output Description

The output from VHPLOT consists of two sections (figures 9 A & B). Figure 9A is the input option section. The first line consists of this particular start and stop time as well as the aircraft that produced the input data. The next part of this section describes the particular plots selected. In this example the lowest frame to be plotted (plot 1) is temperature (TEMP), and the limits of calibration are from 0 to 10,000 counts. The calibration for this plot is

$$TEMP = 0.0101(COUNTS) - 50.8054$$

Figure 9B shows a calibrated listing of each plotted value. The first two columns show the elapsed seconds. The columns of VCO values are self explanatory. An important note is that since any particular housekeeping value occurs once every ten second every other housekeeping value is listed. However the one selected for plotting is indicated by the word "VALUE" next to it.

The plot output (figure 10) shows how each of the plots are offset so that each axis limit can be easily read. Any fluctuation in any of the housekeeping curves is a sure indication of some sort of device problem.

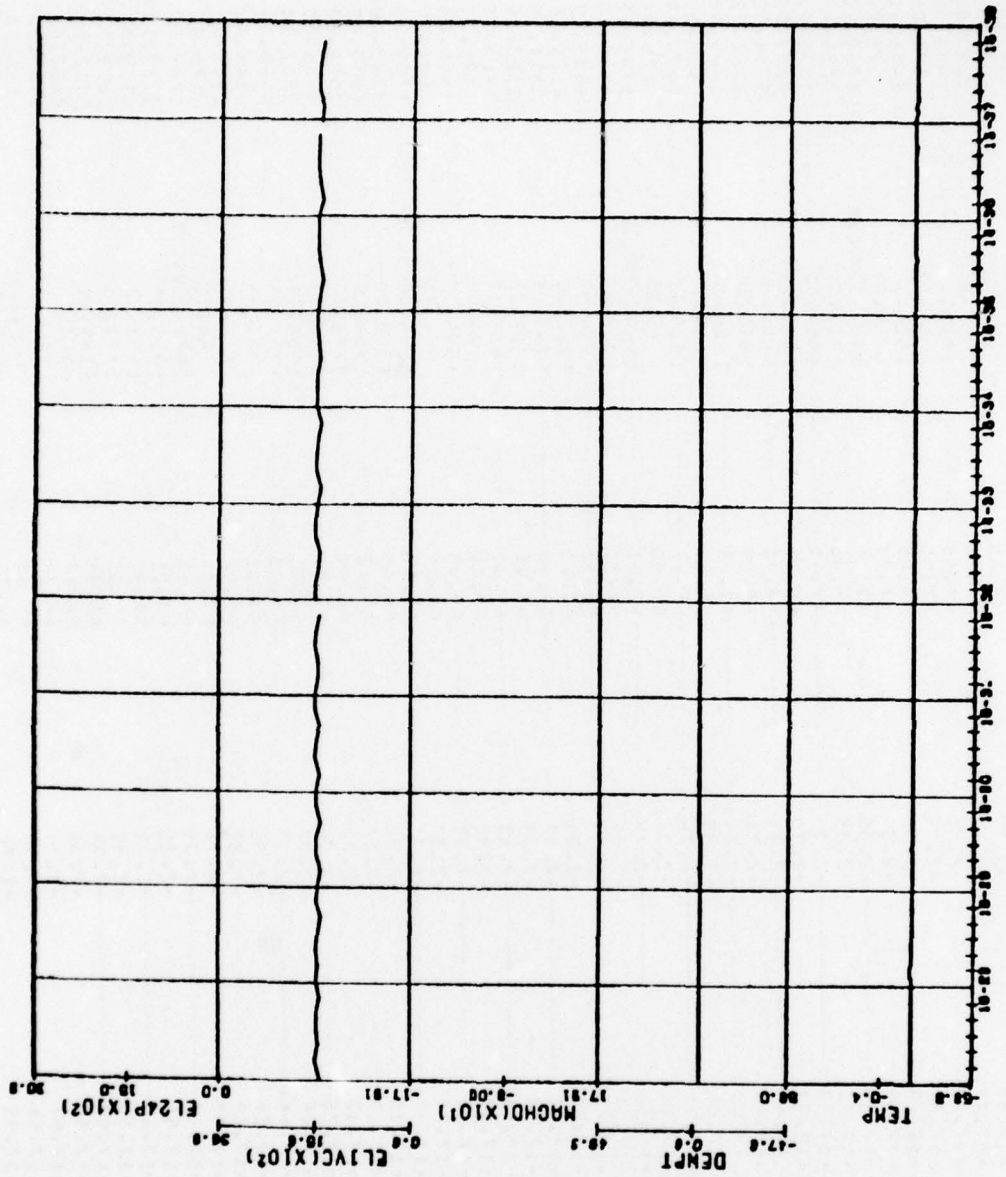
```
START= 15-27-00 ------STOP= 15-33-00----- E MODEL

PLOT 1 IS  VCC NUMBER  2      LABELLED TEMP
  INTERCEPT=  -50.3054   SLOPE=      .0101    MINIMUM=      0.0000    MAXIMUM=10000.0000

PLOT 2 IS  VCC NUMBER  5      LABELLED DEWPT
  INTERCEPT=  -47.5149   SLOPE=      .0097    MINIMUM=      0.0000    MAXIMUM=10000.0000

PLOT 3 IS  VCC NUMBER  7      LABELLED MAGMO
  INTERCEPT=  170.0374   SLOPE=     -.0353    MINIMUM=      0.0000    MAXIMUM=10000.0000

PLOT 4 IS HSKP NUMBER  8      LABELLED EL1VC
  INTERCEPT=    0.0000   SLOPE=     1.0000    MINIMUM=      0.0000    MAXIMUM= 3000.0000

PLOT 5 IS HSKP NUMBER 12      LABELLED EL24P
  INTERCEPT=    0.0000   SLOPE=     1.0000    MINIMUM=      0.0000    MAXIMUM= 3000.0000
```


Figure 9A: VHPLOT Sample Output

ESEC	TIME	TEMP	DEWPT	MAGHD	EL1VC	EL24P
781	15:27:00	-17.59	-2.38	66.65	65.00	177.00
782	15:27:01	-17.65	-2.37	66.65	1427.00VALUE	1726.00
783	15:27:02	-17.69	-2.37	66.62	1200.00	3372.00VALUE
784	15:27:03	-17.69	-2.37	66.65	1553.00	1539.00
785	15:27:04	-17.68	-2.37	66.65	2780.00	2821.00
786	15:27:05	-17.68	-2.37	66.65	5144.00	5011.00
787	15:27:06	-17.72	-2.37	66.65	1957.00	2823.00
788	15:27:07	-17.75	-2.36	66.65	1506.00	1465.00
789	15:27:08	-17.78	-2.36	66.65	64.00	176.00
790	15:27:09	-17.75	-2.36	66.65	1506.00	1485.00
791	15:27:10	-17.69	-2.36	66.73	64.00	176.00
792	15:27:11	-17.66	-2.36	67.01	1492.00VALUE	1760.00
793	15:27:12	-17.71	-2.35	66.98	1359.00	3394.00VALUE
794	15:27:13	-17.77	-2.35	67.01	1554.00	1539.00
795	15:27:14	-17.73	-2.35	66.98	2779.00	2820.00
796	15:27:15	-17.69	-2.35	67.01	5144.00	5011.00
797	15:27:16	-17.66	-2.35	66.98	1956.00	2822.00
798	15:27:17	-17.64	-2.34	67.01	1506.00	1465.00
799	15:27:18	-17.68	-2.35	66.98	65.00	177.00
800	15:27:19	-17.56	-2.34	67.01	1505.00	1484.00
801	15:27:20	-17.60	-2.34	66.98	65.00	176.00
802	15:27:21	-17.63	-2.34	67.01	1440.00VALUE	1758.00
803	15:27:22	-17.61	-2.34	67.01	1255.00	3364.00VALUE
804	15:27:23	-17.62	-2.33	66.95	1554.00	1539.00
805	15:27:24	-17.60	-2.34	67.01	2780.00	2821.00
806	15:27:25	-17.58	-2.33	66.98	5143.00	5011.00
807	15:27:26	-17.54	-2.33	67.01	1957.00	2823.00
808	15:27:27	-17.56	-2.33	66.98	1506.00	1465.00
809	15:27:28	-17.59	-2.32	67.01	64.00	176.00
810	15:27:29	-17.60	-2.33	66.98	1506.00	1484.00
811	15:27:30	-17.78	-2.32	66.76	64.00	176.00
812	15:27:31	-17.65	-2.33	66.65	1484.00VALUE	1790.00
813	15:27:32	-17.68	-2.32	66.65	1360.00	3392.00VALUE
814	15:27:33	-17.67	-2.32	66.65	1554.00	1539.00
815	15:27:34	-17.83	-2.32	66.65	2779.00	2821.00
816	15:27:35	-17.78	-2.32	67.01	5143.00	5011.00
817	15:27:36	-17.69	-2.32	67.01	1956.00	2822.00
818	15:27:37	-17.68	-2.32	66.98	1506.00	1486.00
819	15:27:38	-17.78	-2.31	67.01	64.00	175.00
820	15:27:39	-17.79	-2.32	66.98	1506.00	1485.00
821	15:27:40	-17.77	-2.31	67.01	64.00	176.00
822	15:27:41	-17.72	-2.31	66.98	1471.00VALUE	1779.00
823	15:27:42	-17.68	-2.31	67.01	1313.00	3369.00VALUE
824	15:27:43	-17.66	-2.31	66.95	1553.00	1539.00
825	15:27:44	-17.66	-2.31	67.01	2779.00	2820.00
826	15:27:45	-17.63	-2.30	66.98	5144.00	5012.00
827	15:27:46	-17.59	-2.31	66.83	1957.00	2822.00
828	15:27:47	-17.57	-2.30	66.37	1505.00	1485.00
829	15:27:48	-17.54	-2.30	65.65	65.00	176.00
830	15:27:49	-17.59	-2.30	64.76	1505.00	1484.00
831	15:27:50	-17.64	-2.30	63.86	64.00	176.00
832	15:27:51	-17.76	-2.30	62.97	1432.00VALUE	1821.00
833	15:27:52	-17.82	-2.29	62.11	1277.00	3368.00VALUE
834	15:27:53	-17.89	-2.30	61.53	1553.00	1539.00
835	15:27:54	-17.94	-2.29	61.43	2779.00	2820.00
836	15:27:55	-17.97	-2.29	61.39	5144.00	5012.00
837	15:27:56	-17.90	-2.30	61.39	1956.00	2822.00
838	15:27:57	-17.81	-2.29	61.43	1506.00	1485.00
839	15:27:58	-17.68	-2.29	61.36	64.00	176.00
840	15:27:59	-17.60	-2.29	61.43	1506.00	1485.00

Figure 9B: VHPLOT Sample Output

Figure 10: VHPLOT Sample Plot



2.7 LWCTIME

2.7.1 Program Description

LWCTIME was written to plot the log of liquid water content vs. time (using either the aircraft or PMS clock) for a given number of minutes from an input start time. It can prepare plots from either a standard INTERCOM terminal (where the output is disposed to a plot queue) or the Tektronix graphics terminal (where the output is displayed in real time).

LWCTIME uses the standard KNOLL1D plot tape (see Appendix 5) as its input which has been previously cataloged onto the disk.

2.7.2 Operating Instructions

To use LWCTIME from a standard INTERCOM terminal, the user must execute the following commands:

```
LOGIN,NAME,PASSWORD,TTYNO↓
M, PLS MOUNT DISK LYCPFI↓
MOUNT, SN=LYCPFI,VSN=LYCPFI↓
SETNAME(LYCPFI)↓
ATTACH,LIB,SMALLONLINE,SN=SHARED↓
LIBRARY(LIB)↓
REQUEST,SMPLOT,*Q↓
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME↓
ATTACH,LGO,LWCTIMEBIN,ID=LEACH↓
LGO↓
[INPUT RESPONSES]
DISPOSE,SMPLOT,SP↓
```

To use LWCTIME from the Tektronix plotting terminal, the user must execute the following commands:

```
LOGIN,NAME,PASSOWRD,TTYNO↓
M, PLS MOUNT DISK LYCPFI↓
MOUNT,SN=LYCPFI,VSN=LYCPFI↓
SETNAME(LYCPFI)↓
ATTACH,LIB,TEKLIB,SN=SHARED↓
LIBRARY(LIB)↓
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME↓
ATTACH,LGO,LWCTIMEBIN,ID=LEACH↓
LGO↓
[INPUT RESPONSES]
```

2.7.3 Input Responses

Regardless of which type of terminal is being use, the program will begin asking questions about the graph to be plotted after the LGO command has been executed. The user must input the following parameters:

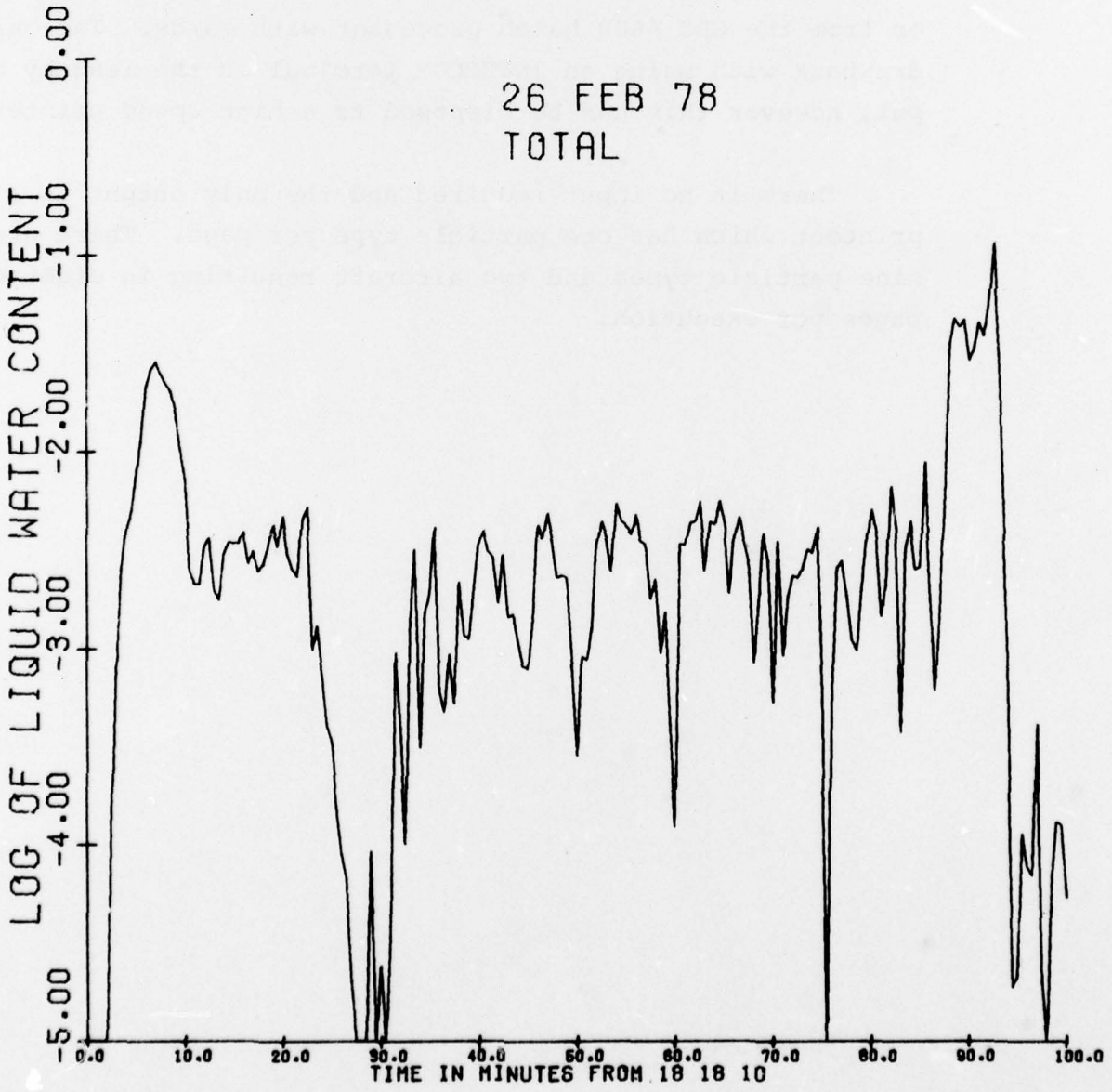
(1) Whether a standard INTERCOM terminal or the Tektronix plotting terminal is being used
(2) The number of minutes to be plotted
(3) Which probe's liquid water content (or their total) is to be graphed
(4) The date of the flight
(5) Whether the time is to be taken from the aircraft clock or the PMS clock
(6) What the desired starting time is

For example, the terminal session in Figure 11 will produce a graph of the log of the total liquid water content vs. time for 100 minutes. The graph will start at 18:18:10 and the time will be taken from the PMS clock. The date of the flight was February 26, 1978 and the plot was being prepared from a standard INTERCOM terminal. Figure 12 shows the graph produced as a result of this session.

Figure 11: LWCTIME Sample Session

```
LGO

ENTER TYPE OF TERMINAL
(STANDARD INTERCOM=1, TEKTRONIX=2)  1

ENTER THE NUMBER OF MINUTES
TO BE PLOTTED 100

ENTER PROBE TYPE
(SCATTER=1, CLOUD=2, PRECIP=3, TOTAL=4)  4

ENTER THE DATE OF THE FLIGHT  26 FEB 78

ENTER CLOCK TO USE (A/C=1, PMS=2)  2

ENTER START TIME  HH MM SS  18 18 10


 END OF PLOTS.
      STOP
       1.196 CP SECONDS EXECUTION TIME
..
```

Figure 12: LWCTIME Sample Plot



2.8 DIAMETER

2.8.1 Program Description

Program DIAMETER calculates and lists the equivalent center diameters and channel limits for each particle type on either the C130E or LEARJET.

DIAMETER can be run either from an INTERCOM terminal or from the CDC 6600 batch processor with cards. The only drawback with using an INTERCOM terminal is the lengthy output, however this can be disposed to a high speed printer.

There is no input required and the only output is a printout which has one particle type per page. There are nine particle types and two aircraft resulting in eighteen pages per execution.

2.8.2 Control cards

```
JOBNM,CM65000,T10.                    ACT          NAME
ATTACH,LGO,DIAMETERBIN,ID=FRANCIS.
LGO.
6/7/8/9
```

INTERCOM USAGE

```
ATTACH,LGO,DIAMETERBIN,ID=FRANCIS.
LGO.
DISPOSE,OUTPUT,PR,IAC
```

LEAR

TYPE 1

MAXIMUM CHANNEL IS 6

CLOUD BRKPT(N) IS 0

CR SIZE LE 0.0 MM

N ADJ= .988*N + .182
CRYSTAL SIZE(MM)=N ADJ*UDMM
EQMD(MM)=1.000*CRSZ**1.000

RAIN

MINIMUM CHANNEL IS 1

PRECIP BRKPT(N) IS 0

CR SIZE GT 0.0 MM

N ADJ= .988*N + .182
CRYSTAL SIZE(MM)=N ADJ*UDMM
EQMD(MM)=1.000*CRSZ**1.000

CLASS	ADJUSTED CLASS	//	CRYSTAL SIZE (MM) CL	PR	//	EQ MELTED DIAMETER (MICRONS) CL	PR	//	CLASS LIMITS CL LOWER - UPPER	PR LOWER - UPPER
1	1.17	//	.02	.2	//	23.40	234.0	//	13.52 - 33.28	135.2 - 332.8
2	2.16	//	.04	.4	//	43.16	431.6	//	33.28 - 53.04	332.8 - 530.4
3	3.15	//	.06	.6	//	62.92	629.2	//	53.04 - 72.80	530.4 - 728.0
4	4.13	//	.08	.8	//	82.68	826.8	//	72.80 - 92.56	728.0 - 925.6
5	5.12	//	.10	1.0	//	102.44	1024.4	//	92.56 - 112.32	925.6 - 1123.2
6	6.11	//	.12	1.2	//	122.20	1222.0	//	112.32 - 132.08	1123.2 - 1320.8
7	7.10	//	.14	1.4	//	141.96	1419.6	//	132.08 - 151.84	1320.8 - 1518.4
8	8.09	//	.16	1.6	//	161.72	1617.2	//	151.84 - 171.60	1518.4 - 1716.0
9	9.07	//	.18	1.8	//	181.48	1814.8	//	171.60 - 191.36	1716.0 - 1913.6
10	10.06	//	.20	2.0	//	201.24	2012.4	//	191.36 - 211.12	1913.6 - 2111.2
11	11.05	//	.22	2.2	//	221.00	2210.0	//	211.12 - 230.88	2111.2 - 2308.8
12	12.04	//	.24	2.4	//	240.76	2407.6	//	230.88 - 250.64	2308.8 - 2506.4
13	13.03	//	.26	2.6	//	260.52	2605.2	//	250.64 - 270.40	2506.4 - 2704.0
14	14.01	//	.28	2.8	//	280.28	2802.8	//	270.40 - 290.16	2704.0 - 2901.6
15	15.00	//	.30	3.0	//	300.04	3000.4	//	290.16 - 309.92	2901.6 - 3099.2

Figure 13A: DIAMETER Sample Output

C130-E

TYPE 1 RAIN

MAXIMUM CHANNEL IS 10 MINIMUM CHANNEL IS 1

CLOUD BRKPT(N) IS 0 PRECIP BRKPT(N) IS 0

CR SIZE LE 0.0 MM CR SIZE GT 0.0 MM

N ADJ= .988*N + .182
CRYSTAL SIZE(MM)=N ADJ*UDMM
EQMD(MM)=1.000*CRSZ**1.000

N ADJ= .988*N + .182
CRYSTAL SIZE(MM)=N ADJ*UDMM
EQMD(MM)=1.000*CRSZ**1.000

CLASS	ADJUSTED CLASS	CRYSTAL SIZE CL	CRYSTAL SIZE PR	EQ MELTED DIAMETER CL	EQ MELTED DIAMETER PR	CLASS LIMITS CL	CLASS LIMITS PR
		(MM)		(MICRONS)		LOWER - UPPER	LOWER - UPPER
1	1.17	.02	.4	23.40	351.0	13.52 - 33.28	202.8 - 499.2
2	2.16	.04	.6	43.16	647.4	33.28 - 53.04	499.2 - 795.6
3	3.15	.06	.9	62.92	943.8	53.04 - 72.80	795.6 - 1092.0
4	4.13	.08	1.2	82.68	1240.2	72.80 - 92.56	1092.0 - 1388.4
5	5.12	.10	1.5	102.44	1536.6	92.56 - 112.32	1388.4 - 1684.8
6	6.11	.12	1.8	122.20	1833.0	112.32 - 132.08	1684.8 - 1981.2
7	7.10	.14	2.1	141.96	2129.4	132.08 - 151.84	1981.2 - 2277.6
8	8.09	.16	2.4	161.72	2425.8	151.84 - 171.60	2277.6 - 2574.0
9	9.07	.18	2.7	181.48	2722.2	171.60 - 191.36	2574.0 - 2870.4
10	10.06	.20	3.0	201.24	3018.6	191.36 - 211.12	2870.4 - 3166.8
11	11.05	.22	3.3	221.00	3315.0	211.12 - 230.88	3166.8 - 3463.2
12	12.04	.24	3.6	240.76	3611.4	230.88 - 250.64	3463.2 - 3759.6
13	13.03	.26	3.9	260.52	3907.8	250.64 - 270.40	3759.6 - 4056.0
14	14.01	.28	4.2	280.28	4204.2	270.40 - 290.16	4056.0 - 4352.4
15	15.00	.30	4.5	300.04	4500.6	290.16 - 309.92	4352.4 - 4648.8

Figure 13B: DIAMETER Sample Output

2.9 LEARPMS

2.9.1 Program Description

Program LEARPMS reformats the PMS-1D data tape produced by the Pertec 9 track recorder on board the LEARJET. The output tape appears identical to that produced by the C130-E Kennedy 7 track recorder. LEARPMS must be run on the CDC 6600 through the batch processor stream. No data cards are needed.

Input and output consists entirely of tapes. The input tape formats are shown in Appendices 11 and 12. The output tape format is shown in Appendix 2.

2.9.2 Control Cards

```
JOBNM,60000,T300,TP1,NT1.          ACC#          NAME
PUASE. TAPE9 IS NINE TRACK CODED
VSN=TAPE9=TAPENO/NT.
VSN,TAPE1=TAPENO.
REQUEST,TAPE9,HD,L,NT.             (9 TRACK - NO RING)
REQUEST,TAPE1,S,HI,RING.
ATTACH LGO,LEARPMSBIN,ID=GLASS,MR=1.
FILE(TAPE9,RT=U,BT=K,MRL=5576,MBL=5576,RB=1,BFS=560)
FILE(TAPE1,RT=U,BT=K,MRL=1024,MBL=1024,RB=1,BFS=105)
LDSET,FILES=TAPE1/TAPE9,PRESET=ZERO.
LGO.
7/8/9  (MULTI-PUNCH)
6/7/8/9 (MULTI-PUNCH)
```

2.9.3 Data Cards

none required

2.10 HIAC1D

2.10.1 Program Description

Program HIAC1D summarizes and tabulates the Aeromet processed data generated by the PMS-1D Knollenberg device aboard the LEARJET.

HIAC1D produces two output tapes (TAPE2 and TAPE7) similar to those written by KNOLL1D. It also prints a listing which has the same meteorological parameters as KNOLL1D.

The input to HIAC1D is a 9 track data tape and as such, it must be executed from cards. Output consists of a formatted listing, a line printer plot, a data summary and two output tapes. The following is a summary of I/O units used in HIAC1D.

UNIT	DESCRIPTION
1	input
2	output plot tape
3	output summary
5	card input
7	RAPP tape output
9	line printer output

2.10.2 Control Cards

```
JOBNM,CM65000,T200,NT1,TP0.**           ACT #     NAME
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT, SN=LYCPFI,VSN=LYCPFI.
ATTACH,LGO,HIAC1DBIN,ID=FRANCIS,SN=LYCPFI.
VSN,TAPE1=LTAXXX/NT.
REQUEST,TAPE1,PE,L,NR,NT.      (9 TRACK - NO RING)
REQUEST,TAPE7,RING,MT,VSN=TAPENO.*      (7 TRACK - RING)
REQUEST,TAPE2,RING,MT,VSN=TAPENO.*      (7 TRACK - RING)
FILE(TAPE1,RT=U,BT=K,MRL=2100,MBL=2100,RB=1,BFS=211)
LDSET,FILES=TAPE1,PRESET=ZERO.
LGO.
REWIND,TAPE3,TAPE9.
COPY,TAPE3.
COPY,TAPE9.
EXIT(S)
REWIND,TAPE3,TAPE9.
COPY,TAPE3.
COPY,TAPE9.
7/8/9
DATA CARDS
6/7/8/9


*    FOR NO RAPP TAPE REMOVE REQUEST,TAPE7,...
*    FOR NO PLOT TAPE REMOVE REQUEST,TAPE2,...
**   FOR EACH OUTPUT TAPE INCREMENT TP0 to TP1, TO TP2
```

2.10.3 Data Card

card 1

col	1-6	TAPE	INPUT TAPE NUMBER (LTAXXX)
	9-10	NEOF	NUMBER OF END OF FILES TO SKIP BEFORE PROCESSING
	15	PREREJ	=0 (DEFAULT) USE CHANNEL 1 PRECIP =1 INTERPOLATE CHANNEL 1 PRECIP

CARDS 2-N+1 (N IS NUMBER OF "PASSES")

col	2-9	IBEG	START PASS TIME	HH:MM:SS
	12-19	IEND	STOP PASS TIME	HH:MM:SS
	21-25	IPASS	PASS NUMBER	
	26-30	INTA	AVERAGING INTERVAL	
	33-65	NED	EDIT PARAMETERS (SEE BELOW)	

NED EDIT PARAMETERS

col	33	FIRST PROBE TO BE EDITED	(I1)
	34	SECOND PROBE TO BE EDITED	(I1)
	35	THIRD PROVE TO BE EDITED	(I1)
	36-37	FIRST CHANNEL TO BE EDITED	(I2)
	38-39	SECOND CHANNEL TO BE EDITED	(I2)
	40-41	THIRD CHANNEL TO BE EDITED	(I2)
	⋮		
	64-65	FIFTEENTH CHANNEL TO BE EDITED	(I2)

THE NED OPTION PERMITS SELECTIVE ZEROING OF DATA BY PROBE AND CHANNEL NUMBER

2.10.4 Output Details

The output listing from HIAClD is shown in figure 14. The first line of output shows the flight date (22 MAR 77) and the input tape (LTA027). The second line contains the start and stop times over which this data had been averaged (15:38:30-15:38:39).

```
TOTAL LWC (liquid water content      gm/M**3)
TOTAL Z   (radar reflectivity        mm**6/m**3)
TOTAL D0  (median volume diameter    microns)
TOTAL UN  (number density            NO/m**3)
TOTAL mK  (LWC/√Z*1000.)
```

are all calculated from the cloud and precip probes only, the scatter probe is not used in these totals. SF, RF, ST and RT are the TWCI (total water content indicator) components;

```
PRES      (pressure millibars)
ALT       (altitude kilometers)
TAS       (true airspeed meters per second)
TEMP      (true temperature centigrade)
DEWP      (dewpoint centigrade)
JW        (liquid water content gm/m**3)
```

are all calibrated VCO values. The remainder of the average summary contains the particle type and indicator. The indicator states whether the particle type is "fixed" or "changes". If the particle type had changed within this averaging interval the values given should be suspect. The "PRECIP CHANNEL ONE:" phrase was explained earlier in this section. Total counts is the sum of all the particles counted within the forty five

channels all three probes).

The next part of the output is a channel by channel listing of the average interval. The column under "CL" is the channel number. The columns under "DIAMETER" are the center diameters (in microns) of any particular channel during this interval. Counts are the sum of all the particles registered in each channel. The columns under "NM-DENSITY" contain the normalized number density of each channel. Number density (number per cubic meter) is normalized by dividing the density by its associated bar width in mm. The columns beneath "LWC" contain the liquid water content of each channel. "NM-DENSITY" and "LWC" are averages over the whole interval. There are three sets of these columns, the one on the left is for the scatter probe, the one on the right for the precip probe and the one in the middle is data derived from the cloud probe.

Beneath the "COUNTS", "NM-DENSITY" and "LWC" columns are the totals for each probe. Lastly beneath these probe totals are the average values for each probe of mK, D_o, UN and Z.

Figure 14: HIAClD Sample Output

START *15:36:30* STOP *15:38:33* 22 MAR 77 HIAC TAPE:LTA027

10 SECOND AVERAGE

PARTICLE TYPE:RAIN (FIXED)

EQUIP CHANNEL 1: ORIGINAL DATA

TOTAL LWC 1.264613E-01 GM/M**3 SF 2.801E+03 PRES 844.10 MB TEMP 7.88 DEG C
TOTAL Z 3.093549E+03 MM**6/M**3 SF 2.772E+03 ALT 1.55 KM DEWP 8.75 DEG C
TOTAL DD 2.549022E+03 MICRONS ST 6.833E+03 TAS 95.10 M/SEC JW .15 GM/M**3
TOTAL UN 4.133619E+04 NO/M**3 RT 7.263E+03 TWCI .03 GM/M**3
TOTAL MK 2.273560E+00 TOTAL COUNTS 20008

DIAMETER MICRONS	TOTAL COUNTS	NM-DENSITY NO/M**3-MM	LWC GM/M**3	DIAMETER MICRONS	TOTAL COUNTS	NM-DENSITY NO/M**3-MM	LWC GM/M**3	DIAMETER MICRONS	TOTAL COUNTS	NM-DENSITY NO/M**3-MM	LWC GM/M**3
2.3	1001	1.303E+03	1.727E-05	23.4	14	1.696E+06	2.249E-04	234.0	19	3.791E+02	5.026E-04
4.3	6334	8.236E+03	6.851E-04	43.2	8	2.527E+05	2.102E-04	431.6	5	1.045E+02	8.692E-04
6.3	6558	8.455E+03	2.231E-03	62.3	3	4.454E+04	1.148E-04	629.2	1	2.203E+01	5.679E-04
8.3	3745	4.332E+03	2.834E-03	82.7	8	7.032E+04	4.112E-04	826.8	0	0.	0.
10.2	1599	2.208E+03	2.456E-03	102.4	3	1.753E+04	1.950E-04	1024.4	0	0.	0.
12.2	339	5.138E+01	9.786E-04	122.2	0	0.	0.	1222.0	0	0.	0.
14.2	44	5.715E+07	1.692E-04	142.0	1	3.446E+07	1.020E-04	1419.6	1	2.754E+01	8.153E-03
16.2	3	3.834E+06	1.704E-05	161.7	2	5.813E+03	2.544E-04	1617.2	1	2.933E+01	1.286E-02
18.1	0	0.	0.	181.5	4	1.251E+04	7.734E-04	1814.8	1	3.148E+01	1.947E-02
20.1	0	0.	0.	201.2	2	6.756E+03	5.696E-04	2012.4	0	0.	0.
22.1	0	0.	0.	221.0	0	0.	0.	2210.0	0	0.	0.
24.1	0	0.	0.	240.8	1	3.942E+03	5.692E-04	2407.6	0	0.	0.
26.1	0	0.	0.	260.5	0	0.	0.	2605.2	1	4.407E+01	8.062E-02
28.0	0	0.	0.	280.3	0	0.	0.	2802.8	0	0.	0.
30.0	0	0.	0.	300.0	0	0.	0.	3000.4	0	0.	0.
TOTAL	13333	2.581E+10	9.437E-03	TOTAL	46	2.114E+06	3.425E-03	TOTAL	29	6.381E+02	1.230E-01

MK= 2.5410E+03 MK= 1.7347E+01 MK= 2.2121E+00

DD= 9.5 (MICRONS) UN= 5.120E+07 (NO/M**3) Z= 1.379E-05 (MM**6/M**3)

DD= 176.7 (MICRONS) UN= 4.177E+04 (NO/M**3) Z= 3.642E-02 (MM**6/M**3)

DD=2553.2 (MICRONS) UN= 1.261E+02 (NO/M**3) Z= 3.094E+03 (MM**6/M**3)

START *15:38:40* STOP *15:38:49* 22 MAR 77 HIAC TAPE:LTA027

10 SECOND AVERAGE

PARTICLE TYPE:RAIN (FIXED)

EQUIP CHANNEL 1: ORIGINAL DATA

TOTAL LWC 1.263633E-02 GM/M**3 SF 2.811E+03 PRES 843.67 MB TEMP 7.51 DEG C
TOTAL Z 2.248867E+01 MM**6/M**3 SF 2.772E+03 ALT 1.56 KM DEWP 8.62 DEG C
TOTAL DD 2.082880E+02 MICRONS ST 6.829E+03 TAS 98.13 M/SEC JW .20 GM/M**3
TOTAL UN 6.769638E+04 NO/M**3 RT 7.268E+03 TWCI .02 GM/M**3
TOTAL MK 6.426438E+00 TOTAL COUNTS 30449

DIAMETER MICRONS	TOTAL COUNTS	NM-DENSITY NO/M**3-MM	LWC GM/M**3	DIAMETER MICRONS	TOTAL COUNTS	NM-DENSITY NO/M**3-MM	LWC GM/M**3	DIAMETER MICRONS	TOTAL COUNTS	NM-DENSITY NO/M**3-MM	LWC GM/M**3
2.3	938	1.131E+03	1.499E-05	23.4	20	2.347E+06	3.111E-04	234.0	19	3.671E+02	4.866E-04
4.3	7027	8.555E+03	7.366E-04	43.2	18	5.570E+05	4.600E-04	431.6	6	1.231E+02	1.024E-03
6.3	9414	1.168E+10	3.061E-03	62.3	21	2.938E+05	7.700E-04	629.2	2	4.244E+01	1.094E-03
8.3	7318	9.247E+03	5.408E-03	82.7	5	4.241E+04	2.480E-04	826.8	1	2.310E+01	1.351E-03
10.2	4313	5.470E+03	6.084E-03	102.4	9	5.142E+04	5.719E-04	1024.4	0	0.	0.
12.2	1224	1.550E+03	2.927E-03	122.2	12	5.026E+04	9.488E-04	1222.0	0	0.	0.
14.2	108	1.363E+03	4.049E-04	142.0	7	2.373E+04	6.921E-04	1419.6	0	0.	0.
16.2	3	3.834E+06	1.678E-05	161.7	4	1.174E+04	4.962E-04	1617.2	0	0.	0.
18.1	2	2.557E+06	1.563E-05	181.5	6	1.807E+04	1.118E-03	1814.8	0	0.	0.
20.1	0	0.	0.	201.2	3	9.726E+07	8.201E-04	2012.4	0	0.	0.
22.1	0	0.	0.	221.0	1	3.488E+03	3.895E-04	2210.0	0	0.	0.
24.1	0	0.	0.	240.8	2	7.542E+03	1.090E-03	2407.6	0	0.	0.
26.1	0	0.	0.	260.5	1	4.190E+03	7.665E-04	2605.2	0	0.	0.
28.0	0	0.	0.	280.3	0	0.	0.	2802.8	0	0.	0.
30.0	0	0.	0.	300.0	0	0.	0.	3000.4	0	0.	0.

2.11 LOOP

2.11.1 Program Description

Program LOOP uses the input data as catalogued by BOBIN and calculates MASS and MEDIAN VOLUME DIAMETER for a measured radar reflectivity. It uses empirical distributions of dimensionless number density ND_o^4/M. The mathematical description of this method may be found in DPSI's Final Report #TR-76-0182.

This program is designed to be run on an INTERCOM terminal with its output file printed at a high speed terminal.

2.11.2 Operating Instructions

```
LOGIN,ID,PASSWORD,TTYNUMBER,SUP↓
ATTACH,LGO,LOOPX4340,ID=BELSKY↓
LGO↓
```

The terminal interaction is fairly self explanatory see figure 15. Note that to end execution a response of 0.0 must be entered for ENTER RADAR Z?

2.11.3 Output Details

Figure 15 contains a complete sample session showing the typical usage.

Figure 15: LOOP Sample Session

```
LOOP

PASS=?  1

FLIGHT DATE (50 CHARS.)=? TESTING DATA FROM E77-51 29 OCT 77

MAXIMUM D/D0 IN INTEGRATION=  6.132
ENTER INSTRUMENT MAXIMUM?  6.0

CALCULATE (C) OR GIVEN (G) MK?  G

MK=?  12.0

ENTER RADAR Z?  100.0

ALPHA=    .9884831     BETA=    .9845171     (MK)=     12.000
M <(MK)*(ZR)**.5>  =     120.000  ORIGINAL D0 =     .565
OUTPUT D0=    .553
OUTPUT M=    120.095
OUTPUT Z=    100.001
(MK) AT INFINITY=     12.010
MEDIAN=    .551
OBJECT M=    119.999
OBJECT Z=     99.998
MAX. DIAM.=    3.316


ENTER RADAR Z?  0.0

TYPE FOR COMPUTING CENTER\ BATCH,TAPE6,PRINT,OKAP
TYPE FOR LY CENTER(NEXT DOOR) BATCH,TAPE6,PRINT,AC,OKAP


      END  LOOP
      2.768 CP SECONDS EXECUTION TIME
COMMAND- BATCH,TAPE6,PRINT,AC,OKAP
```

2.12 BOBIN

2.12.1 Program Description

Program BOBIN is a data input program that prepares data for program LOOP. It accepts or modifies the 21 data points that specify number density versus size (as output from program KNPLT1D).

There are three basic functions of BOBIN. Function 1 is to input a new set of 21 points. Function 2 converts these 21 points to their respective N_i values (number density in this size class) and then permits reentry of the N_i values. Function 3 is for data smoothing. The input data (21 points) is smoothed or recalculated. It is designed to be run on an INTERCOM terminal.

2.12.2 Operating Instructions

```
LOGIN,ID,PASSWORD,TTYNUMBER,SUP↓
REQUEST,NFILE,*PF↓
ATTACH,DATA,BOBINX4340,ID=BELSKY↓
DATA↓
INPUT RESPONSES
UNLOAD,FILE,NFILE↓
LOGOUT↓
```

2.12.3 Output Details

A complete output sample is shown on the following page in figure 16.

```
COMMAND- ATTACH,DATA,BOBINX4340,ID=BELSKY,MR=1

 PF CYCLE NO. = 002
COMMAND- ATTACH,LOOP,LOOPX4340,ID=BELSKY,MR=1

 PF CYCLE NO. = 001
COMMAND- REQUEST,NFILE,*PF

COMMAND- DATA


 ENTERING NEW DATA FILE? NO


 PRINT DATA FILE? YES

        X                Y

 1     .075          3.56218170
 2     .150          2.70169370
 3     .250          1.63594480
 4     .400           .91278868
 5     .600           .64542632
 6     .800           .40244435
 7    1.000           .10986567
 8    1.200          -.18266973
 9    1.400          -.47527677
10    1.600          -.76783842
11    1.800         -1.06958020
12    2.000         -1.38387440
13    2.200         -1.70053140
14    2.400         -2.01716370
15    2.600         -2.33383220
16    2.800         -2.65045310
17    3.000         -2.96713290
18    3.200         -3.28374250
19    3.400         -3.60043360
20    3.600         -3.91703180
21    3.800         -4.23373430
22    4.000         -4.55043470

                A                        B

          0.00000000               0.00000000


 CHANGING FITTING FUNCTION? NO


CHANGING A, B COEFFICIENTS? NO

DO YOU WISH TO ENTER NEW N VALUES?  NO

DO YOU WANT THE FITTING FUNCTION RECALCULATED?  NO


NEW DATA FILE COMPLETE
```

Figure 16: BOBIN Sample Output

2.13 FLTPMS

2.13.1 Program Description

FLTPMS was written to produce a replacement for the PMS-1D tape (should one be needed). It does so by reading an RTX/8 TU-10 flight tape, reformatting the data to be compatible with KNOLL1D, and writing the reformatted data onto a new tape. It is commonly run in batch mode.

FLTPMS requires an RTX/8 TU-10 flight tape as its input tape. The format for this is shown in Appendix 26.

The output tape produced has the same format as a PMS-1D data tape (see Appendix 2).

2.13.2 Control Cards

```
JOBNM,TP2,CM65000,T100.                    PROB NO.      NAME
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
REQUEST,TAPE1,S,HI,MT,RING,VSN=TAPENO1.    (FOR KNOLL1D)
REQUEST,TAPE3,MT,S,VSN=TAPENO3.            (FROM RTX/8)
ATTACH,A1,FLTPMS,ID=FRANCIS
FTN,I=A1,PL=999999,OPT=2.
FILE(TAPE1,RT=U,BT=K,MRL=1024,MBL=1024,RB=1,BFS=105)
FILE(TAPE3,RT=U,BT=K,MRL=1135,MBL=1135,RB=1,BFS=116)
LDSET,FILES=TAPE1/TAPE3,PRESET=ZERO.
LGO.
7/8/9
6/7/8/9
```

2.13.3 Input Cards

none required

2.14 EWERCOMP

2.14.1 Program Description

Program EWERCOMP takes the EWER VCO values from the PMS-1D buffer and calculates a least square regression line against the KNOLL1D derived total liquid water content. The output consists of a scatter plot with the regression line plotted through the data, and an output listing of the least square coefficients, RMS, and calculated values with their variance from the input data.

2.14.2 Operating Instructions

```
LOGIN,ID,PASSWORD,TTYNUMB,SUP↓
ATTACH,CRT,OFFLINECRT.↓
LIBRARY,CRT.↓
REQUEST,TAPE39,*Q.↓
DISPOSE,TAPE39,*FL.↓
ATTACH,TAPE1,PLOTTAPE,ID=GLASS.↓    (KNOLL1D TAPE2)
ATTACH,LGO,EWERCOMPBINX2876,ID=GLASS.↓
LGO.↓
LOGOUT
```

2.15 EWERTIME

2.15.1 Program Description

Program EWERTIME was written to plot PMS-1D total liquid water content for the same time period and on the same scale as that used on the Aerospace derived plots. This permits a visual correlation of the data. Input to EWERTIME is the KNOLL1D output TAPE2. Output is a CALCOMP pen plot. EWERTIME can be executed from either batch or INTERCOM.

2.15.2 Operating Instructions

```
JOBNM,CM60000,T20.                          ID      NAME
ATTACH,PEN,ONLINEPEN.
LIBRARY(PEN).
REQUEST,PLOT,*Q.
DISPOSE,PLOT,*PL.
PAUSE. PLS MOUNT DISKLYCPFI
MOUNT SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
ATTACH,TAPE1,PLOTTAPE,ID=GLASS.      (FROM KNOLL1D)
ATTACH,LGO,EWERTIMEBIN,ID=GLASS.
LGO.
6/7/8/9
```

2.16 HIGHDEN

2.16.1 Program Description

HIGHDEN was written to produce scatter plots of height (in feet) vs. the log of the number density (N/M^3) measured during a user specified interval of time. It can prepare plots from either a standard INTERCOM terminal (by disposing the output to a plot queue) or in real time from the Tektronix graphic terminal.

HIGHDEN uses the standard KNOLL1D plot tape which has previously been cataloged onto the disk as its input tape.

2.16.2 Operating Instructions

To use HIGHDEN from a standard INTERCOM terminal, the user must execute the following commands:

```
LOGIN,NAME,PASSWORD,TTYNO↓
M, PLS MOUNT DISK LYCPFI↓
MOUNT,SN=LYCPFI,VSN=LYCPFI↓
SETNAME(LYCPFI)↓
ATTACH,LIB,SMALLONLINE,SN=SHARED↓
LIBRARY(LIB)↓
REQUEST,SMPLOT,*Q↓
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME↓
ATTACH,LGO,HIGHDENBIN,ID=LEACH↓
LGO↓
[INPUT REQUESTS]
DISPOSE,SMPLOT,SP↓
```

To use HIGHDEN from the Tektronix plotting terminal, the user must execute the following commands:

```
LOGIN,NAME,PASSWORD,TTYNO
M, PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI
SETNAME(LYCPFI)
ATTACH,LIB,TEKLIB,SN=SHARED
LIBRARY(LIB)
ATTACH,TAPE1,KNOLL1DPLOTTAPE,ID=NAME
ATTACH,LGO,HIGHDENBIN,ID=LEACH
LGO
[INPUT REQUESTS]
```

2.16.3 Plotting Options

Regardless of which type of terminal is being used, the program will begin asking questions about the graph to be plotted after the LGO command is executed. The user must input the following parameters:

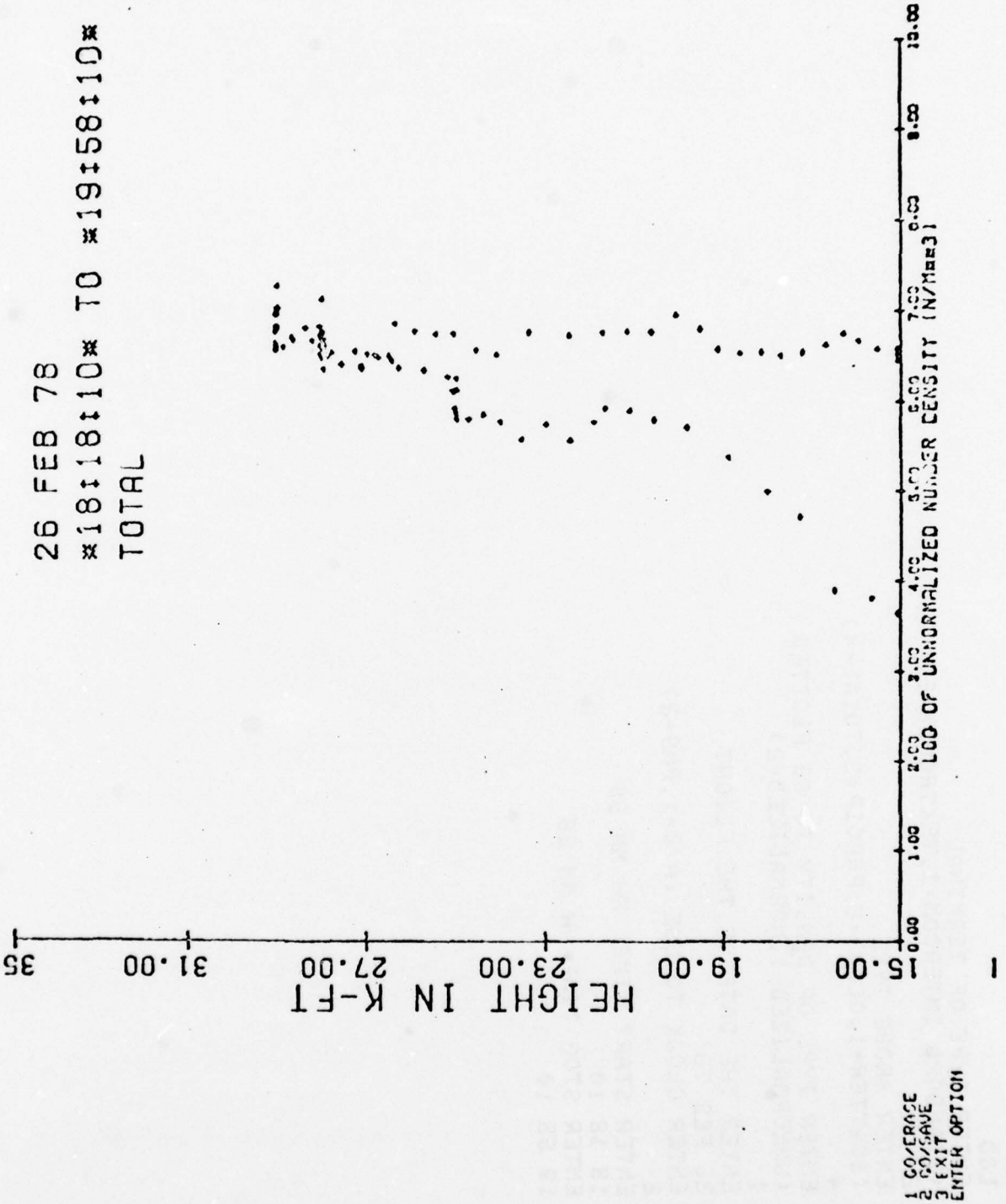
(1) Whether a standard INTERCOM terminal or the Tektronix plotting terminal is being used
(2) Which probe's number density (or their total) is to be graphed
(3) Whether normalized or unnormalized density is to be used
(4) The date of the flight
(5) Whether the time is to be taken from the aircraft clock or the PMS clock
(6) The starting time of the interval of interest
(7) The ending time of the interval of interest

For example, the terminal session in Figure 17 will produce a scatter plot of the height vs. the log of the total unnormalized number density measured from 18:18:10 until 19:58:10. The time will be taken from the PMS clock. The date of the flight was February 26, 1978 and the plot was being prepared from the Tektronix plotting terminal. Figure 18 shows the graph produced as a result of this session.

Figure 17: HIGHDEN Sample Session

```
LGO
ENTER TYPE OF TERMINAL
(STANDARD INTERCOM=1,TEKTRONIX=2)
2
ENTER PROBE TYPE
(SCATTER=1,CLOUD=2,PRECIP=3,TOTAL=4)
4
ENTER TYPE OF DENSITY TO BE PLOTTED
(UNNORMALIZED=1,NORMALIZED=2)
1
ENTER THE DATE OF THE FLIGHT
26 FEB 78
ENTER CLOCK TO USE (A/C=1,PMS=2)
2
ENTER START TIME  HH MM SS
18 18 10
ENTER STOP TIME HH MM SS
19 58 10
```

Figure 18: HIGHDEN Sample Plot



3.1 KN2UTIL

3.1.1 Program Description

This program provides a means of verifying the correct operation of the PMS-2D devices. It also produces a data summary that is useful in the manual particle typing required for other analyses. KN2UTIL reads the standard nine track PMS-2D particle image tape (Appendix 13 & 14). The program must be run through the 6600 batch processor. Output is in the form of a line printer listing and either CRT or line printer generated images.

To summarize, the following results are produced by this program:

1. A tape summary of all data recorded that includes
   a. record type (slow or fast)
   b. record length
   c. record number (absolute and by type)
   d. record time

2. A data listing by record type as specified
   a. slow data - line printer
   b. fast data (on selected device)
      1. line printer
      2. 35 mm film

3.1.2 Control Cards

```
JOBNM,CM75000,T400,NT1.                    PROB NO.      NAME
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
ATTACH,CRT,CRTPLOTS.
LIBRARY,CRT.                                [1]
REQUEST,TAPE39,*Q.
DISPOSE,TAPE39,*FM.
SETNAME(LYCPFI)
VSN,TAPE1=TAPENO/NT.     (TAPENO IS PMS-2D DATA ACQUISITION TAPE)
REQUEST,TAPE1,PE,L,NR,NT.
FILE(TAPE1,RT=U,BT=K,MRL=5576,MBL=5576,RB=1,BFS=560)
ATTACH,LGO,KN2UTILBIN,ID=GLASS,MR=1.
LDSET,FILES=TAPE1,PRESET=ZERO.
LGO.
REWIND,SUM,SOUT,LOUT.
COPY,SUM.[2]
COPY,SOUT.[3]
COPY,LOUT.[4]
EXIT(S)
COPY,SUM.[2]
COPY,SOUT.[3]
COPY,LOUT.[4]
7/8/9
DATA
6/7/8/9
```

[1] REMOVE WHEN CRT NOT DESIRED (ID CARD COL 1-3 MUST BE BLANK)

[2] REMOVE WHEN SUMMARY NOT WANTED

[3] REMOVE WHEN SHORT RECORD LISTING NOT WANTED

[4] REMOVE WHEN LONG RECORD LISTING NOT WANTED

3.1.3 Data Cards

CARD 1 ID CARD

cc 1-3 PEN FOR CRT OUTPUT
BLANK FOR LONG RECORD LISTING ON PAPER

cc 11-16 TAPE NUMBER

cc 21-26 FLIGHT DATE DDMONYR (NO SPACES)

CARD 2 OPTION CARD

cc 2-3 NUMBER OF END OF FILES TO PROCESS (DEFAULT=1)

cc 6-10 NUMBER OF ABSOLUTE RECORDS TO READ (DEFAULT=999999)

CARD 3 SS NAMELIST CARD*

cc 2-4 $ SS

VALID VARIABLES

ARECB	ABSOLUTE BEGINNING RECORD
ARECE	ABSOLUTE ENDING RECORD
SRECB	BEGINNING SLOW RECORD TO BE LISTED
SRECE	ENDING SLOW RECORD TO BE LISTED
LRECB	BEGINNING LONG RECORD TO BE LISTED
LRECE	ENDING LONG RECORD TO BE LISTED

CARD 4

cc 2-5 $END

CARD 5 TIMEFLAG NAMELIST CARD**

cc 2-9 $TIMFLAG

VALID VARIABLES

TF	CHANGE DEFAULT TIME FLAG CODE (DEFAULT IS TF = 0,1,0,1,0,1,0,1)

CARD 6

cc 2-5 $END

* $ SS cards are in standard NAMELIST format. When the ARECB and ARECE variables are specified all records whether they be long or slow that are between records ARECB and ARECE inclusively will be listed. (The ARECB or ARECE variable specifies the actual tape record number).

Specific short and/or long records may be dumped selectively by using the SRECB, SRECE, LRECB and LRECE variables. The example in figure 19 depicts the correct usage.

If the CRT option was selected then the long records will be put onto 35 mm film.

** $ TIMFLAG cards are in standard namelist format. TF is dimensioned as length = 8. Timing word is indicated by a bit pattern of 01010101 in bits 1-8 of any scan, however due to hardware problems it may be something different. The TIMFLAG cards are a means of changing the flag key AFTER it is known. If the incorrect pattern is 00101010 then the namelist cards should read:

```
@$TIMEFLAG
@TF=0,0,1,0,1,0,1,0,
@$END
```

where @ = blank column

Record type	S	S	S	F	F	S	F	F	S	S	F	F	F	F	S	S	F	F	S	F
Record number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Slow sequence #	1	2	3			4			5	6					7	8			9	
Fast sequence #				1	2		3	4			5	6	7	8			9	10		11

CASE A: To dump all of the above records either of the following methods should be used.

1. records 1-20

   or

2. Slow records 1-9

   and

   Fast records 1-11

USE:

```
@$SS ARECB=1,ARECE=20 $END
          or
@$SS SRECB=1,SRECE=9,FRECB=1,FRECE=9 $END
```

CASE B: To dump the records indicated by the aboe rectangel use either:

1. records 8-15

   or

2. Slow records 5-7

   and

   Fast records 4-8

```
@$SS ARECB=8,ARECE=15 $END
          or
@$SS SRECB=5,SRECE=7,FRECB=4,FRECE=6 $END
```

where @ = blank column

Figure 19: KN2UTIL Sample Input

3.1.4 Output Details

Figure 20A shows the tape summary that is produced whenever KN2UTIL is run. The listing shows the count of each record in terms of both total records and record type. Each long record (indicated by an L in column 1) has a probe identifier (CL for cloud, PR for precip) shown in column 3. All long records (particle data) must be 547 words in length. The short records (an S in column 2) must have a length of 86 words. A sync byte (should be 1111), a clock time, and an elapsed second counter are all shown for each slow record. Any record that is not either 547 or 86 words is indicated by an X in the left hand column. These records are ignored by all other PMS-2D processing programs.

A short record summary is depicted in figure 20B. These records contain ten 1-second VCO samples, status words for each probe, and five percent clock rate samples. Also there is space allocated to multiplex 15 PMS-1D channel counts each second, and 16 analog data channels each record. At the present time this space is not being utilized. The eight VCO's that appear at the bottom, are calibrated, and averaged (over 10 seconds) by KN2UTIL; they appear for convenience only and are a means of visually verifying the VCO hardware.

A long record line printer output is shown in figures 20 C & D. This output is quite lengthy, at one line per scan, a three record set uses approximately 16 pages. At the beginning of each record, the times (clock & elapsed), record count, and overload status are shown. The elapsed time (based on the current clock sample rate) between particles is also shown. Note if a record appears without an

elapsed second count between each particle, there is a good chance that the time flag may be incorrect (see Section 3.1.3 for a method to correct this). At the end of each record (figure 20D) the elapsed time between particles is summed and printed.

Figure 20E also depicts the long records using a different media. Each record is shown on one 35 mm frame. The information is identical to that on the line printer. The big advantage to this media is the amount of paper used. Whereas the line printer output has a faster (same day, usually) throughput time.

```
   L   CL      AREA= 3724    LREC= 3639    LENGTH= 547 WORDS
   L   PR      AREA= 3725    LREC= 3640    LENGTH= 547 WORDS
   L   CL      AREA= 3726    LREC= 3641    LENGTH= 547 WORDS
   L   PR      AREA= 3727    LREC= 3642    LENGTH= 547 WORDS
   L   CL      AREA= 3728    LREC= 3643    LENGTH= 547 WORDS
   L   PR      AREA= 3729    LREC= 3644    LENGTH= 547 WORDS
   L   CL      AREA= 3730    LREC= 3645    LENGTH= 547 WORDS
   L   PR      AREA= 3731    LREC= 3646    LENGTH= 547 WORDS
   L   CL      AREA= 3732    LREC= 3647    LENGTH= 547 WORDS
   L   PR      AREA= 3733    LREC= 3648    LENGTH= 547 WORDS
   S           AREA= 3734    SREC=   94    LENGTH=  86 WORDS  SYNC 1111   BEGIN TIME IS 22:37:30   (  3420 SECONDS)
   L   CL      AREA= 3735    LREC= 3649    LENGTH= 547 WORDS
   L   PR      AREA= 3736    LREC= 3650    LENGTH= 547 WORDS
   L   CL      AREA= 3737    LREC= 3651    LENGTH= 547 WORDS
   L   PR      AREA= 3738    LREC= 3652    LENGTH= 547 WORDS
   L   CL      AREA= 3739    LREC= 3653    LENGTH= 547 WORDS
   L   PR      AREA= 3740    LREC= 3654    LENGTH= 547 WORDS
   L   CL      AREA= 3741    LREC= 3655    LENGTH= 547 WORDS
   L   PR      AREA= 3742    LREC= 3656    LENGTH= 547 WORDS
   L   CL      AREA= 3743    LREC= 3657    LENGTH= 547 WORDS
   L   PR      AREA= 3744    LREC= 3658    LENGTH= 547 WORDS
   L   CL      AREA= 3745    LREC= 3659    LENGTH= 547 WORDS
   L   PR      AREA= 3746    LREC= 3660    LENGTH= 547 WORDS
   L   CL      AREA= 3747    LREC= 3661    LENGTH= 547 WORDS
   L   PR      AREA= 3748    LREC= 3662    LENGTH= 547 WORDS
   L   CL      AREA= 3749    LREC= 3663    LENGTH= 547 WORDS
   S           AREA= 3750    SREC=   95    LENGTH=  86 WORDS  SYNC 1111   BEGIN TIME IS 22:37:40   (  3430 SECONDS)
   L   CL      AREA= 3751    LREC= 3664    LENGTH= 547 WORDS
   L   PR      AREA= 3752    LREC= 3665    LENGTH= 547 WORDS
   L   PR      AREA= 3753    LREC= 3666    LENGTH= 547 WORDS
   L   CL      AREA= 3754    LREC= 3667    LENGTH= 547 WORDS
   L   PR      AREA= 3755    LREC= 3668    LENGTH= 547 WORDS
   L   CL      AREA= 3756    LREC= 3669    LENGTH= 547 WORDS
   S           AREA= 3757    SREC=   96    LENGTH=  86 WORDS  SYNC 1111   BEGIN TIME IS 22:37:50   (  3440 SECONDS)
   L   PR      AREA= 3758    LREC= 3670    LENGTH= 547 WORDS

   ENDFILE   5

   ENDFILE   6
```

Figure 20A: KN2UTIL Sample Output

SREC= 1 APEC= 13 AT 4633.004 SECONDS

A/C	CLOCK		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
20:02:00		VCD'S	1	1	0	6730	0	4276	4796	3545	5034	5046	3125	7603				
		CLOUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PCT CLOCK =4613
20:02:01		VCD'S	1	1	0	6725	0	4250	4734	3550	5034	5047	3126	7605				
		PRECIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PRECIP TOT= 0
20:02:02		VCD'S	1	1	0	6728	0	4279	4792	3555	5034	5047	3127	7610				
		CLOUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PCT CLOCK =4609
20:02:03		VCD'S	1	1	0	6740	0	4274	4736	3558	5034	5046	3129	7611				
		PRECIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PRECIP TOT= 0
20:02:04		VCD'S	1	1	0	6738	0	4271	4735	3559	5034	5047	3130	7608				
		CLOUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PCT CLOCK =4641
20:02:05		VCD'S	1	1	0	6730	0	4276	4734	3559	5034	5046	3129	7607				
		PRECIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PRECIP TOT= 0
20:02:06		VCD'S	1	1	0	6729	0	4272	4733	3556	5034	5047	3129	7602				
		CLOUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PCT CLOCK =4615
20:02:07		VCD'S	1	1	0	6727	0	4264	4736	3555	5033	5047	3127	7600				
		PRECIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PRECIP TOT= 0
20:02:08		VCD'S	1	1	0	6725	0	4264	4739	3551	5034	5046	3125	7597				
		CLOUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PCT CLOCK =4612
20:02:09		VCD'S	1	1	0	6726	0	4269	4801	3547	5034	5046	3124	7593				
		PRECIP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	)	PRECIP TOT= 0

STATUS WORDS										
	CLOUD	PRECIP	SLOW ANALOG DATA				VCD ID'S			
PCT OV'LD	0	0	(1)	1	(9)	1	1 PRESSURE	1.076E+01	MB	
20 TOTAL	25	18	(2)	1	(10)	1	2 DEL PRESS	2.068E+00	MB	
#1 REF V	4945	1623	(3)	1	(11)	1	3 TEMP	-8.013E+01	DEG C	
#32 REF V	1120	1636	(4)	1	(12)	1	4 DEWPOINT	2.212E+02	DEG C	
-15V SUPP	1515	1504	(5)	1	(13)	1	5 _WC (JW)	0.		GM/M**3
-12V SUPP	1212	1209	(6)	1	(14)	1	TRUE AIRSP	2.750E+02	KNOTS	
+5V SUPP-A	4984	4978	(7)	1	(15)	1	IND AIRSP	5.200E+01	KNOTS	
+5V SUPP-B	5085	5120	(8)	1	(16)	1	HEIGHT	2.565E+04	METERS	
+15V SUPP	1486	1475								
MIRROR TMP	107	74								

Figure 147. 20B: KN2UTIL Sample Output

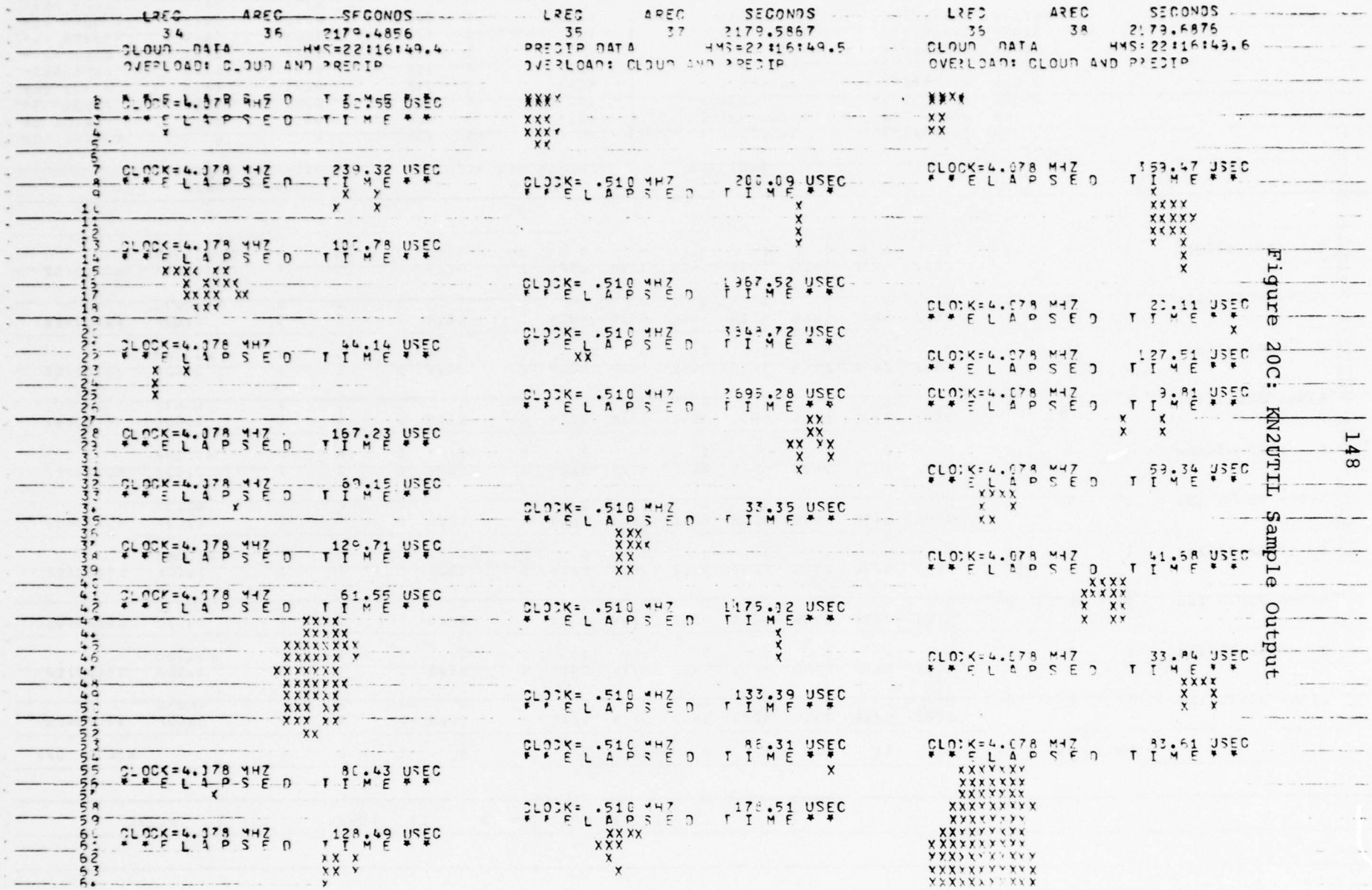


Figure 20C: KN2UTIL Sample Output

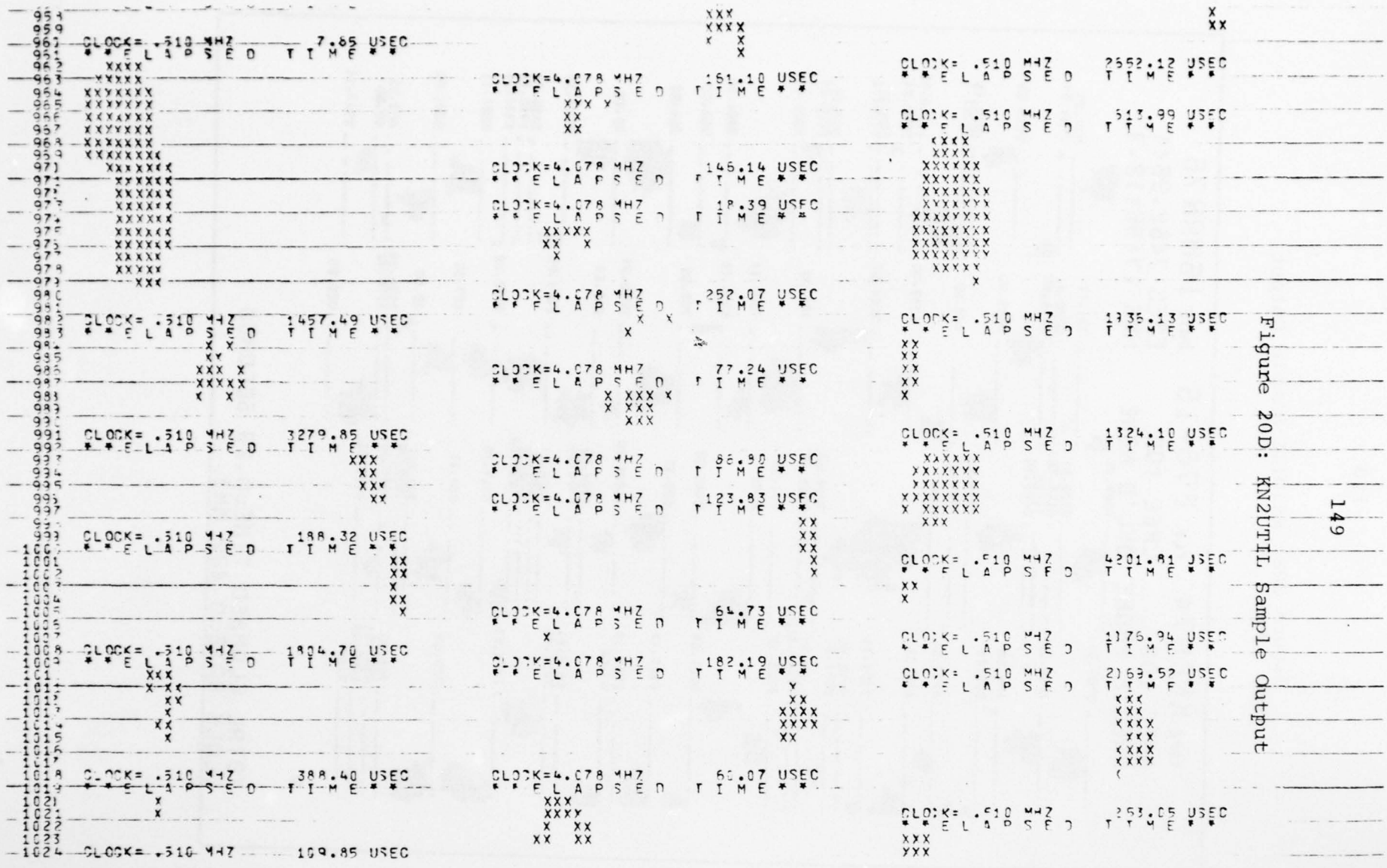
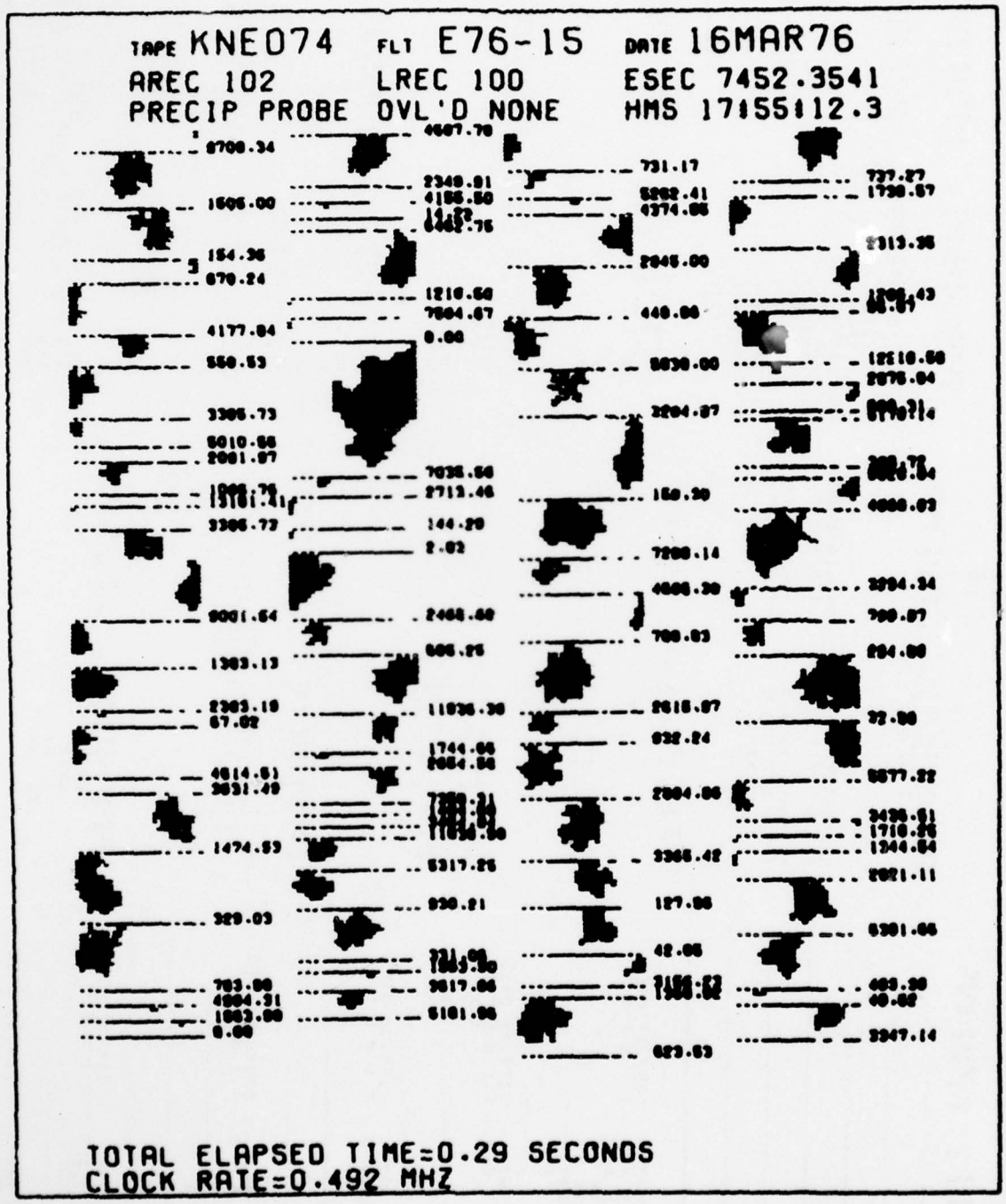


Figure 20D: KN2UTIL Sample Output

Figure 20E: KN2UTIL Sample Output



3.2 TWODEE

3.2.1 Program Description

This program is concerned with transforming the 32 diode scans into actual particles or crystals. The technique developed uses the real time principle of a one-pass calculation; that is, while the particle is being determined certain key parameters are also being calculated. This means that after the initial pattern recognition pass, the definition of the particle is fully specified.

Program TWODEE uses the standard PMS-2D particle image tape (Appendix 14 & 15). A particle tape(s) (Appendix 13) is produced as input to program KNOLL2D. An output listing that contains a summary of the particle tape is also included. This summary can optionally be selected as either a short or long format. The short format includes particle header information and the fundamental parameters of each particle.

3.2.2 Control Cards

```
JOBNM,CM65000,T2000,NT1.
ATTACH,LL,TIMELFT.
FILE(TAPE1,RT=U,BT=K,MRL=5576,MBL=
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
ATTACH,LGO,TWODEEBIN,ID=GLASS,MR=1.
REQUEST,TAPE2,*PF,SN=LYCPFI.
VSN,TAPE1=TAPENO/NT.
REQUEST,TAPE1,PE,L,NR,NT.
LDSET,PRESET=ZERO,FILES=TAPE1.
LOAD,LGO,LL.
EXECUTE.
CATALOG,TAPE2,TWODDATA,ID=GLASS.
REWIND,TAPE3.
COPY,TAPE3.
EXIT(S)
CATALOG,TAPE2,TWODDATA,ID=GLASS
REWIND,TAPE3.
COPY,TAPE3.
7/8/9
DATA CARDS
6/7/8/9
```

3.2.2 Control Cards

```
JOBNM,CM65000,T2000,NT1.                PROB NO.      NAME
ATTACH,LL,TIMELFT.
FILE(TAPE1,RT=U,BT=K,MRL=5576,MBL=5576,RB=1,BFS=560)
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
ATTACH,LGO,TWODEEBIN,ID=GLASS,MR=1.
REQUEST,TAPE2,*PF,SN=LYCPFI.
VSN,TAPE1=TAPENO/NT.
REQUEST,TAPE1,PE,L,NR,NT.
LDSET,PRESET=ZERO,FILES=TAPE1.
LOAD,LGO,LL.
EXECUTE.
CATALOG,TAPE2,TWODDATA,ID=GLASS.
REWIND,TAPE3.
COPY,TAPE3.
EXIT(S)
CATALOG,TAPE2,TWODDATA,ID=GLASS.
REWIND,TAPE3.
COPY,TAPE3.
7/8/9
DATA CARDS
6/7/8/9
```

3.2.3 Data Cards

CARD 1 IDENTIFICATION CARD

cc 1-6	XYR-NN	FLIGHT ID (COL 1 MUST BE E OR L)
cc 11-19	DDMONYR	FLIGHT DATE

CARD 2 OPTION CARD

cc 5	NLEN	0 = FULL CALCULATION OF MAXIMUM LENGTH
		1 = APPROXIMATION OF MAXIMUM LENGTH
cc 6-10	NEOF	NUMBER OF END OF FILES TO PROCESS
cc 11-15	NOUT	0 = SUMMARY OUTPUT
		1 = FULL OUTPUT
cc 16-20	NRST	NUMBER OF FEET USED IN PREVIOUS EXECUTION (USED FOR RESTARTING JOB)
cc 21-25	NTSW*	0 = USE REAL TIME CLOCK
		1 = INPUT TIME OF FIRST SLOW RECORD
cc 76-80	NFEET	NUMBER OF FEET ON CURRENT REEL (DEFAULT 2400)

CARD 3- N PASS CARDS

cc 2-9	HH:MM:SS	SAMPLING START TIME
cc 12-19	HH:MM:SS	SAMPLING STOP TIME
cc 25	QTYPE	= I IF SNOW OR ICE IN PASS
		= R IS ONLY RAIN IN PASS

* IF NTSW=1 NEXT CARD MUST BE A TIME CARD IN FORMAT

@HH:MM:SS

where @ = blank column

3.2.4 Output Details

Figure 21A depicts the short particle tape summary listing. There is one row of information per record. This includes: record number and length, clock time, record number from the nine track tape, slow record number, sample time and rate, aircraft, probe and overload information, and also six VCO counts.

The full particle tape summary (figure 21B) includes all of the above in addition to the fundamental parameters for each particle contained within the record. In this listing the header information is shown in the two half-lines at the top. Each full line contains the particle parameters.

RECORD	WORDS	HH:MM:SS.F	SPEC&FREC	SAMPLE-MS	CLKDTE-YK	ACSPROBE	OVERLOAD	PRESS	DEL P	TEMP	DEWPT	TAS	JW-LWC
1	512	22:22: 9.8	600007	2597	82429	3	0	327508189	6435	6265	5344	4242	5027
2	512	22:22: 9.8	600007	2597	82429	3	0	327508189	6435	6265	5344	4242	5027
3	92	22:22: 9.8	600007	2597	82429	3	0	327508189	6435	6265	5344	4242	5027
4	352	22:22:10.8	600008	1486	82429	2	0	327508189	6435	6265	5344	4242	5027
5	512	22:22:11.8	600009	1172	82429	2	0	327508189	6435	6265	5344	4242	5027
6	62	22:22:11.8	600009	1172	82429	2	0	327508189	6435	6265	5344	4242	5027
7	512	22:22:12.8	600010	2793	82429	3	2	327508189	6435	6265	5344	4242	5027
8	512	22:22:12.8	600010	2793	82429	3	2	327508189	6435	6265	5344	4242	5027
9	252	22:22:12.8	600010	2793	82429	3	2	327508189	6435	6265	5344	4242	5027
10	512	22:22:13.8	600011	2003	82429	2	10	327508189	6435	6265	5344	4242	5027
11	512	22:22:13.8	600011	2003	82429	2	10	327508189	6435	6265	5344	4242	5027
12	62	22:22:13.8	600011	2003	82429	2	10	327508189	6435	6265	5344	4242	5027
13	512	22:22:14.8	600012	3075	82429	3	8	327508189	6435	6265	5344	4242	5027
14	512	22:22:14.8	600012	3075	82429	3	8	327508189	6435	6265	5344	4242	5027
15	212	22:22:14.8	600012	3075	82429	3	8	327508189	6435	6265	5344	4242	5027
16	512	22:22:15.8	600013	972	82429	2	8	327508189	6435	6265	5344	4242	5027
17	112	22:22:15.8	600013	972	82429	2	8	327508189	6435	6265	5344	4242	5027
18	512	22:22:16.8	600014	1724	82429	3	10	327508189	6435	6265	5344	4242	5027
19	512	22:22:16.8	600014	1724	82429	3	10	327508189	6435	6265	5344	4242	5027
20	92	22:22:16.8	600014	1724	82429	3	10	327508189	6435	6265	5344	4242	5027
21	392	22:22:17.8	600015	1809	82429	2	10	327508189	6435	6265	5344	4242	5027
22	512	22:22:18.8	600016	1229	82429	3	10	327508189	6435	6265	5344	4242	5027
23	332	22:22:18.8	600016	1229	82429	3	10	327508189	6435	6265	5344	4242	5027
24	272	22:22:19.8	1700019	662	83195	2	10	326808189	6455	6322	5346	4268	5026
25	512	22:22:20.8	1700019	985	83195	3	8	326808189	6455	6322	5346	4268	5026
26	152	22:22:20.8	1700019	985	83195	3	8	326808189	6455	6322	5346	4268	5026
27	442	22:22:21.8	1700020	3211	83195	2	8	326808189	6455	6322	5346	4268	5026
28	512	22:22:22.8	1700021	1823	83195	3	10	326808189	6455	6322	5346	4268	5026
29	512	22:22:22.8	1700021	1823	83195	3	10	326808189	6455	6322	5346	4268	5026
30	202	22:22:22.8	1700021	1823	83195	3	10	326808189	6455	6322	5346	4268	5026
31	512	22:22:23.8	1700022	1408	83195	2	10	326808189	6455	6322	5346	4268	5026
32	22	22:22:23.8	1700022	1408	83195	2	10	326808189	6455	6322	5346	4268	5026
33	512	22:22:24.8	1700023	2119	83195	3	10	326808189	6455	6322	5346	4268	5026
34	512	22:22:24.8	1700023	2119	83195	3	10	326808189	6455	6322	5346	4268	5026
35	32	22:22:24.8	1700023	2119	83195	3	10	326808189	6455	6322	5346	4268	5026
36	512	22:22:25.8	1700024	362	83195	2	2	326808189	6455	6322	5346	4268	5026
37	512	22:22:26.8	1700025	3066	83195	3	2	326808189	6455	6322	5346	4268	5026
38	512	22:22:26.8	1700025	3066	83195	3	2	326808189	6455	6322	5346	4268	5026
39	312	22:22:26.8	1700025	3066	83195	3	2	326808189	6455	6322	5346	4268	5026
40	512	22:22:27.8	1700026	792	83195	2	2	326808189	6455	6322	5346	4268	5026
41	192	22:22:27.8	1700026	792	83195	2	2	326808189	6455	6322	5346	4268	5026
42	512	22:22:28.8	1700027	1207	83195	3	2	326808189	6455	6322	5346	4268	5026
43	452	22:22:28.8	1700027	1207	83195	3	2	326808189	6455	6322	5346	4268	5026
44	512	22:22:29.8	2800029	135	82589	2	10	326208190	6442	6290	5367	4245	5030
45	72	22:22:29.8	2800029	135	82589	2	10	326208190	6442	6290	5367	4245	5030
46	512	22:22:30.8	2800030	618	82589	3	10	326208190	6442	6290	5367	4245	5030
47	272	22:22:30.8	2800030	618	82589	3	10	326208190	6442	6290	5367	4245	5030
48	512	22:22:31.8	2800031	1026	82589	2	10	326208190	6442	6290	5367	4246	5030
49	512	22:22:32.8	2800032	2122	82589	3	10	326208190	6442	6290	5367	4246	5030
50	512	22:22:32.8	2800032	2122	82589	3	10	326208190	6442	6290	5367	4246	5030

Figure 21A: TWODEE/TWODDMP Sample Output

RECORD 162 512 WORDS

HH:MM:SS.F	SREC&FREC	SAMPLE-MS	CLKRTE-XK	AC&PROBE	OVERLOAD
PRESS	DEL P	TEMP	DEWPT	TAS	JW-LWC
10:18:35.0	12100182	115	9E809	3	10
59E208233	1	1	353-	0	556.

AREA	PERIM	HF PROJ	VF PROJ	H PROJ	V PROJ	UNUSED	UMAX	THETA	VOLUME
-88	52	8	17	8	18	0	17.89	0.00	0.00
-28	28	5	8	6	8	0	8.72	0.00	0.00
54	38	8	11	8	11	0	11.40	0.00	0.00
-83	49	7	15	6	16	0	15.78	0.00	0.00
-7	16	2	6	2	6	0	6.16	0.00	0.00
1	4	1	1	1	1	0	1.21	0.00	0.00
1	4	1	1	1	1	0	1.21	0.00	0.00
-51	34	7	9	7	10	0	10.20	0.00	0.00
12	22	4	4	5	6	0	4.83	0.00	0.00
16	30	5	6	6	9	0	6.91	0.00	0.00
-23	24	4	6	4	8	0	8.47	0.00	0.00
14	24	5	5	5	7	0	6.04	0.00	0.00
-25	24	4	7	5	7	0	7.53	0.00	0.00
36	30	7	6	7	8	0	9.32	0.00	0.00
-8	12	3	3	3	3	0	3.62	0.00	0.00
62	38	9	10	9	10	0	11.73	0.00	0.00
2	6	1	2	1	2	0	2.12	0.00	0.00
-55	44	5	15	9	18	0	15.41	0.00	0.00
38	28	7	7	7	7	0	8.45	0.00	0.00
58	52	9	14	11	15	0	15.32	0.00	0.00
2	6	1	2	1	2	0	2.12	0.00	0.00
16	30	5	6	6	9	0	6.91	0.00	0.00
-95	72	9	23	11	25	0	23.65	0.00	0.00
58	42	9	10	9	12	0	11.73	0.00	0.00
-20	26	3	9	4	9	0	9.24	0.00	0.00
-74	46	6	17	6	17	0	17.51	0.00	0.00
9	18	3	5	4	5	0	5.42	0.00	0.00
2	6	1	2	1	2	0	2.12	0.00	0.00
-34	32	5	10	5	11	0	10.59	0.00	0.00
-84	46	8	13	9	14	0	14.13	0.00	0.00
-62	42	6	11	8	13	0	12.30	0.00	0.00
-16	28	4	6	5	8	0	6.61	0.00	0.00
-21	32	5	9	6	10	0	9.65	0.00	0.00
82	46	11	12	11	12	0	14.14	0.00	0.00
-154	72	16	14	16	19	0	18.63	0.00	0.00
-1	4	1	1	1	1	0	1.21	0.00	0.00
87	50	9	14	10	15	0	15.32	0.00	0.00
-12	22	2	9	2	9	0	9.11	0.00	0.00
-45	32	6	6	6	9	0	9.91	0.00	0.00
198	72	13	12	16	23	0	15.35	0.00	0.00
14	26	5	4	6	7	0	5.70	0.00	0.00
10	18	6	2	6	2	0	6.16	0.00	0.00
134	58	12	16	12	17	0	18.00	0.00	0.00
-1	4	1	1	1	1	0	1.21	0.00	0.00
-51	32	8	7	6	7	0	9.32	0.00	0.00
-57	38	6	10	8	11	0	11.40	0.00	0.00
-44	30	6	9	6	9	0	9.91	0.00	0.00
203	76	14	22	16	22	0	24.04	0.00	0.00
25	22	5	6	5	6	0	6.91	0.00	0.00
-73	44	9	11	9	13	0	12.61	0.00	0.00

Figure 21B: TWODEE/TWODDMP Sample Output

3.3 TWODDMP

3.3.1 Program Description

In the event that TWODEE was run without the summary option, program TWODDMP will produce a similar summary without actually recreating the particle tape. This saves considerable computer time. Note that the input tape to this program is a particle tape (TWODEE output) and not the PMS-2D acquisition tape.

3.3.2 Control Cards

```
JOBNM,CM65000,T100,TP1.                    PROB NO.      NAME
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME,LYCPFI.
VSN,TAPE2=TAPENO.
REQUEST,TAPE2.
ATTACH LOG,TWODDMPBIN,ID=GLASS,MR=1.
LDSET,PRESET=ZERO.
LGO.
7/8/9
DATA
6/7/8/9
```

3.3.3 Data Cards

Only one card is required. A blank in column 1 will produce the long form output; any other character in column 1 may be used for the short format.

3.3.4 Output Details

The summary output from this program is identical to the summary produced by program TWODEE. Refer to section 3.2.4 for a description.

3.4 KNOLL2D

3.4.1 Program Description

Although KNOLL2D is in a developmental stage, and is still not quite considered a production program, documentation is included here for purposes of report completeness. Eventually it will replace KNOLL1D as the primary post processing program.

The program utilizes many of the routines and algorithms of KNOLL1D, however the big advantage is the greatly enhanced data. Input is from the particle tape produced as output from program TWODEE. The output includes all of that produced by the 1D system plus additional tables and summaries. It is run through the 6600 batch processor.

3.4.2 Control Cards

```
JOBNM,CM65000,T400.                          PROB NO.      NAME
PAUSE. PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
ATTACH,TAPE2,TWODDATA,ID=GLASS,MR=1.
ATTACH,LGO,KNOLL2DBIN,ID=GLASS,MR=1.
LGO.
7/8/9
DATA CARDS
6/7/8/9
```

3.4.3 Data Cards

CARD 1 FLIGHT CARD

cc 1-6	XYR-NN	FLIGHT IDENTIFICATION
cc 11-19	DDMONYR	FLIGHT DATE

CARD 2 OPTION CARD

cc 1-5	AVERAGING INTERVAL (SECONDS)	
cc 10	IPRS	= 0 KISTLER PRESSURE
		= 1 BACKUP PRESSURE

CARD 3-N PASS CARDS

cc 2-9	HH:MM:SS	START OF SAMPLING TIME
cc 12-19	HH:MM:SS	STOP OF SAMPLING TIME
cc 24-25		PARTICLE TYPE FOR CLOUD PROBE
cc 29-30		PARTICLE TYPE FOR PRECIP PROBE

3.4.4 Output Details

The first type of output produced by KNOLL2D is similar to that produced by KNOLL1D. All references made are to figure 22A.

A) The number of one second data samples that were averaged to make this table

B) the start and stop time of this interval

C) flight identification

D) particle typing indicators

E) the channel number for reference

F) the center diameter for this channel of this probe. It is calculated by melting the maximum length.

G) the normalized density. It is calculated by computing the number of particles that would be detected by this channel size in a cubic meter of sample volume. Then for comparison with the other channels it is normalized by dividing it by the channel barwidth.

H) The liquid water content for this channel above are only repeated once for each channel of each probe. F, G, and H, cloud on the left, and the precip probe on the right.

I) The set of calibrated VCO and VCO derived values. The basic VCO values are PRESSURE, DEWPOINT and TRUE AIRSPEED.

HEIGHT is calculated from PRESSURE. TEMPERATURE and JW-LWC are both VCO's that are adjusted by airspeed. The C AIRSPEED is a calculated alue given by PRESSURE, PRESSURE GRADIENT and TEMPERATURE.

J) The column under REJ is the number of particle used for computation in each channel when end rejection is applied. TOT is the total number counted in this channel Thus TOT-REJ= number of particle touching an end diode. There is one table for each probe.

K) Under each probe is a probe summary of various meteorological parameters. There is also a set for the TOTAL, this is the total of cloud and precip combined

1) M liquid water content
2) Z derived radar reflectivity
3) D0 median volume diameter
4) MK ratio of M to the square root of Z
5) SAMPLE (SEC)
how many seconds elapsed collecting data for this average. This is the sum of the timing marks between all the particles that made up this average.

There are five different ways of categorizing two dimensional particles, by maximum length, horizontal feret projection, area, average projection ratio, and equivalent circle ration. The relationships between these categories is illustrated by KNOLL2D. There are five pages of distribution matrices, two per page, one for the cloud probe and one for precip (see figures 22B - 22F). They demonstrate the relations between any two of these categories. These matrices are given once per pass and are therefore pass totals. References are given to figure 22B.

A) The pass that generated this data

B) Sampling start and stop times

C) The x axis parameter

D) which probe

E) particle type used

F) Total number of sampling seconds (see K-5 in figure 22A)

G) Totals of this row and which "channels" were used in these totals, values are sums of number density

H) the y axis paramter

I) The number density of all particles fitting in this x,y intercept. This number is given in scientific notation. i.e. uv + z = uv.x 10^{z} The + sign can take on the following

values and meaning:
+ positive exponent
* positive exponent and only one particle made up this entry
- negative exponent
_ (underline) negative exponent and only one particle made up this entry

*J) The size limits of this row. i.e. channel 01 has those particles whose maximum length is one or two diodes long

*K) same as J for the columns

L) same as G for the columns

* for maximum length, horizontal feret projection, and area these limits are number of diodes.
for the ratios they are non-dimensional numbers

The last part of a KNOLL2D printout is a comparison of LWC, Z and other parameters for a complete pass, calculated by different methods. The method used for the first section was by maximum length. Thus the first of these three comparisons are also calculated by maximum length, the second by horizontal Feret projection, the third and last is calculated by area. The output is shown in figures 22G - 22I and is identical in format with the first section figure 22A. The difference between the outputs is that these pass averages are centered one per page and have the plot type descriptor above it.

2 SECOND INTERVAL START 16:37:28
STOP 16:37:29

---FLIGHT INFORMATION---
- E77-23 22 MAR 77 -

PARTICLE TYPES
CL: RAIN
PP: RAIN

MS-2D PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER)

CH	CLOUD PROBE EQMD	CLOUD PROBE NO-DENS*	CLOUD PROBE LWC	PRECIP PROBE EQMD	PRECIP PROBE NO-DENS*	PRECIP PROBE LWC
1	56.5	0.	0.	464.3	1.277E+01	2.633E-04
2	106.2	0.	0.	857.8	9.526E+00	1.245E-03
3	156.9	0.	0.	1256.4	4.537E+00	1.871E-03
4	206.6	0.	0.	1654.1	4.527E+00	4.251E-03
5	256.7	0.	0.	2057.4	1.568E+00	2.730E-03
6	306.6	0.	0.	2452.9	6.028E+00	1.861E-02
7	356.6	0.	0.	2850.6	3.013E+00	1.464E-02
8	406.5	0.	0.	3250.3	1.506E+00	1.385E-02
9	456.5	0.	0.	3650.1	6.024E+00	6.143E-02
10	506.5	0.	0.	4050.0	0.	0.
11	556.5	0.	0.	4451.9	0.	0.
12	606.5	0.	0.	4851.8	1.506E+00	3.601E-02
13	656.5	0.	0.	5251.7	0.	0.
14	706.5	0.	0.	5651.7	1.505E+00	5.691E-02
15	756.5	0.	0.	6051.6	0.	0.

	CLOUD	PRECIP	TOTAL
M (GM/M**3)	0.	2.088E-01	2.088E-01
Z (MM**6/M**3)	0.	3.517E+04	3.517E+04
DD(MICRONS)	0.	3.777E+03	3.776E+03
MK(M/Z**.5)	0.	1.114E-03	1.112E-03
SAMPLE(SEC)	0.000	7.862	

		REJ	TOT	REJ	TOT
HEIGHT	(METERS)	9031.57	0	0	2	2
PRESSURE	(MB-K)	305.81	0	0	6	6
TEMPERATURE	(DEG C)	-42.61	0	0	3	3
DEWPOINT	(DEG C)	-28.64	0	0	3	3
C AIR SPEED	(M/SEC)	131.96	0	0	1	1
T AIR SPEED	(M/SEC)	127.44	0	0	4	4
JW-LWC	(GM/M**3)	-.01	0	0	2	2
			0	0	1	1
			0	0	0	0
			0	0	0	0
			0	0	1	1
			0	0	0	0
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	0	0
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	0	0
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	0	0
			0	0	2	2

4 SECOND INTERVAL START 16:37:45
STOP 16:37:48

---FLIGHT INFORMATION---
- E77-23 22 MAR 77 -

PARTICLE TYPES
CL: RAIN
PP: RAIN

MS-2D PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER)

CH	CLOUD PROBE EQMD	CLOUD PROBE NO-DENS*	CLOUD PROBE LWC	PRECIP PROBE EQMD	PRECIP PROBE NO-DENS*	PRECIP PROBE LWC
1	56.5	2.719E+05	1.369E-03	464.3	1.391E+01	2.869E-04
2	106.2	1.758E+05	5.611E-03	857.8	4.152E+00	5.427E-04
3	156.9	6.042E+04	6.084E-03	1256.4	6.591E+00	2.719E-03
4	206.6	4.243E+04	1.118E-02	1654.1	2.631E+00	2.496E-03
5	256.7	2.115E+04	9.350E-03	2057.4	6.571E-01	1.190E-03
6	306.6	5.474E+03	4.127E-03	2452.9	1.970E+00	6.084E-03
7	356.6	1.399E+03	1.660E-03	2852.6	1.313E+00	6.372E-03
8	406.5	0.	0.	3252.3	6.565E-01	4.727E-03
9	456.5	0.	0.	3652.1	6.564E-01	6.694E-03
10	506.5	0.	0.	4050.0	6.567E-01	9.142E-03
11	556.5	0.	0.	4451.9	6.563E-01	1.212E-02
12	606.5	0.	0.	4851.8	6.562E-01	1.559E-02
13	656.5	0.	0.	5251.7	6.562E-01	1.930E-02
14	706.5	0.	0.	5651.7	0.	0.
15	756.5	0.	0.	6051.6	1.312E+00	6.231E-02

	CLOUD	PRECIP	TOTAL
M (GM/M**3)	3.978E-02	1.489E-01	1.888E-01
Z (MM**6/M**3)	9.232E-01	3.975E+04	3.976E+04
DD(MICRONS)	2.114E+02	5.180E+03	4.709E+03
MK(M/Z**.5)	4.105E-02	7.505E-04	9.475E-04
SAMPLE(SEC)	13.353	18.096	

		REJ	TOT	REJ	TOT
HEIGHT	(METERS)	9033.77	110	122	5	5
PRESSURE	(MB-K)	305.71	280	337	6	6
TEMPERATURE	(DEG C)	-42.69	201	244	10	10
DEWPOINT	(DEG C)	-29.27	164	187	4	4
C AIR SPEED	(M/SEC)	131.44	67	75	1	1
T AIR SPEED	(M/SEC)	129.98	16	20	3	3
JW-LWC	(GM/M**3)	-.01	4	4	2	2
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	1	1
			0	0	0	0
			0	0	2	2

Figure 22A: KNOLL20 Sample Output

(A) PASS 1 DISTRIBUTION MATRICES

(B) START 15:30:00
STOP 15:37:49

(C) HORIZONTAL FEPET PROJECTION (D) CLOUD PROBE (E) RAIN (F) 418.979 SECOND SAMPLE

(H)	*01*	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*		TOTAL (G) 01-16
	01	34+3															(1 - 2)	34+3
M	02	93+2	40+2														(3 - 4)	14+3
A	03	20+1	17+2	13+2													(5 - 6)	32+2
X	04	94-1	34+0	13+2	72+1												(7 - 8)	21+2
I	05	41-1	57-1	47+0	92+1	25+1											(9 - 10)	12+2
M	06	12-1	44-2	42-1	39+0	45+1	50+0										(11 - 12)	55+1
U	07	41-2	13-1	94-2	71-1	27+0	24+1	26+0									(13 - 14)	30+1
M	08			14-1	15-1	83-1	27+0	92+0	99-1								(15 - 16)	14+1
	09		44-2		51-2	17_1	37-1	11+0	31+0	87-2							(17 - 18)	49+0
L	10				51-2	56-2	61_2	34-1	84_1	14+0	10-1						(19 - 20)	28+0
E	11					56-2	61-2	14-1	23_1	87_1	51-1						(21 - 22)	19+0
N	12						61-2	68-2		87-2	10_1	24-1					(23 - 24)	56-1
G	13											12-1					(25 - 26)	12-1
T	14									87-2	10-1						(27 - 28)	19-1
H	15												20-1				(29 - 30)	20-1
	16																(31 - 32)	

(I)

(K)

	(1)	(3)	(5)	(7)	(9)	(11)	(13)	(15)	(17)	(19)	(21)	(23)	(25)	(27)	(29)	(31)
	(2)	(4)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(22)	(24)	(26)	(28)	(30)	(32)

(L)

TOTAL	4.43E+04	2.72E+03	7.41E+02	1.34E+02	2.57E+01	3.67E+00	2.04E+00	0.
01-16	5.71E+03	1.69E+03	3.19E+02	5.19E+01	8.15E+00	0.	0.	0.

HORIZONTAL FEPET PROJECTION PRECIP PROBE RAIN 460.976 SECOND SAMPLE

	01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*		TOTAL 01-16
	01	58-1															(1 - 2)	58-1
M	02	34-1															(3 - 4)	34-1
A	03	27-1															(5 - 6)	27-1
X	04	18-1															(7 - 8)	18-1
I	05	13-1															(9 - 10)	13-1
M	06	96-2															(11 - 12)	96-2
U	07	73-2															(13 - 14)	73-2
M	08	69-2															(15 - 16)	69-2
	09	67-2															(17 - 18)	67-2
L	10	54-2															(19 - 20)	54-2
E	11	43-2															(21 - 22)	43-2
N	12	47-2															(23 - 24)	47-2
G	13	37-2															(25 - 26)	37-2
T	14	34-2															(27 - 28)	34-2
H	15	39-2															(29 - 30)	39-2
	16	36-1															(31 - 32)	36-1

	(1)	(3)	(5)	(7)	(9)	(11)	(13)	(15)	(17)	(19)	(21)	(23)	(25)	(27)	(29)	(31)
	(2)	(4)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(22)	(24)	(26)	(28)	(30)	(32)

TOTAL	2.42E+01	0.	0.	0.	0.	0.	0.	0.
01-16	0.	0.	0.	0.	0.	0.	0.	0.

Figure 22B: KNOLL2D Sample Output

PASS 1 DISTRIBUTION MATRICES

START 16:30:00
STOP 16:37:49

AREA — CLOUD PROBE — RAIN — 416.979 SECOND SAMPLE

	01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*		TOTAL
	01	34+3															(1 - 2)	34+3
M	02	11+3	31+2														(3 - 4)	14+3
A	03	16+1	15+2	15+2	14+1												(5 - 6)	32+2
Y	04	29-1	41+0	51+1	12+2	34+1											(7 - 8)	21+2
I	05		10+0	17+0	12+1	03+1	26+1	15-1									(9 - 10)	12+2
M	06		11-1	29-1	69-1	76+0	30+1	16+1	61-1								(11 - 12)	55+1
U	07			29-1	27-1	47-1	44+0	15+1	02+0	43-1							(13 - 14)	30+1
M	08					17-1	11-1	12+0	63+0	51+0	11+0	68-2					(15 - 16)	14+1
	09					44-2			28-1	12+0	21+0	11+0					(17 - 18)	49+0
L	10						10-1		07-2	72-1	67-1	91-1	39-1				(19 - 20)	28+0
E	11								10-1	56-2	36-1	23-1	70-1	41-1			(21 - 22)	19+0
N	12										61-2		41-1	87-2			(23 - 24)	56-1
G	13													12-1			(25 - 26)	12-1
T	14													19-1			(27 - 28)	19-1
H	15															20-1	(29 - 30)	20-1
	16																(31 - 32)	
	(1)(5)(10)(17)(26)(40)(55)(71)(91)(111)(131)(161)(191)(221)(251)(281)																	
	(4)(9)(16)(25)(39)(54)(70)(90)(110)(130)(160)(190)(220)(250)(280)(****)																	

TOTAL 4.52E+04 2.03E+03 1.24E+03 3.18E+02 7.59E+01 2.36E+01 8.13E+00 0.
01-16 4.60E+03 1.45E+03 6.10E+02 1.67E+02 4.28E+01 1.51E+01 0. 2.04E+00

AREA — PRECIP PROBE — RAIN — 460.976 SECOND SAMPLE

	01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*		TOTAL
	01	58-1															(1 - 2)	58-1
M	02	34-1															(3 - 4)	34-1
A	03	15-1	11-1														(5 - 6)	27-1
Y	04		18-1														(7 - 8)	18-1
I	05		13-1		11-3												(9 - 10)	13-1
M	06			96-2													(11 - 12)	96-2
U	07			73-2													(13 - 14)	73-2
M	08			69-2													(15 - 16)	69-2
	09			39-2	27-2												(17 - 18)	67-2
L	10				54-2												(19 - 20)	54-2
E	11				42-2	11-3											(21 - 22)	43-2
N	12				45-2	11-3											(23 - 24)	47-2
G	13				37-2												(25 - 26)	37-2
T	14					34-2											(27 - 28)	34-2
H	15					39-2											(29 - 30)	39-2
	16					93-2	10-1	50-2	42-2	31-2	12-2	13-2	05-3	02-3	01-3	11-3	(31 - 32)	36-1
	(1)(5)(10)(17)(26)(40)(55)(71)(91)(111)(131)(161)(191)(221)(251)(281)																	
	(4)(9)(16)(25)(39)(54)(70)(90)(110)(130)(160)(190)(220)(250)(280)(****)																	

TOTAL 1.08E+01 2.77E+00 1.68E+00 4.97E-01 3.07E-01 1.27E-01 3.17E-02 0.
01-16 4.27E+00 2.07E+00 1.00E+00 4.23E-01 1.16E-01 8.46E-02 2.11E-02 1.06E-02

Figure 22C: KNOLL2D Sample output

PASS 1 DISTRIBUTION MATRICES

START 15:30:00
STOP 16:37:49

AVERAGE PROJECTION RATIO — CLOUD PROBE — RAIN — 410.979 SECOND SAMPLE

		01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*		TOTAL 01-15
	01	34+3																(1 - 2)	34+3
M	02	14+3	55+0	80+0	64-1													(3 - 4)	14+3
A	03	25+2	44+1	21+1	46+0	40-1												(5 - 6)	32+2
X	04	13+2	54+1	17+1	66+0	17+0		51_2										(7 - 8)	21+2
I	05	83+1	25+1	96+0	35+0	15+0				56_2								(9 - 10)	12+2
M	06	33+1	15+1	44+0	15+0	74-1			61_2	11-1								(11 - 12)	55+1
U	07	15+1	91+0	36+0	75-1	81-1	61_2	61_2										(13 - 14)	30+1
M	08	62+0	51+0	17+0	91-1	14-1												(15 - 16)	14+1
	09	20+0	1?+0	76-1	21-1	76_2												(17 - 18)	49+0
L	10	46-1	12+0	90-1	23-1	10_1		87_2										(19 - 20)	28+0
E	11	85-1	64-1	49-1	38-1													(21 - 22)	19+0
N	12	22-1	35-1															(23 - 24)	56-1
G	13			12_1														(25 - 26)	12-1
T	14		87_2		10_1													(27 - 28)	19-1
H	15				20_1													(29 - 30)	20-1
	16																	(31 - 32)	
		(1.0)	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(2.0)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)		
		(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(2.0)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)		

TOTAL	5.90E+02	1.19E+02	1.86E+01	1.48E+00	1.11E+00	0.	0.	0.
06-15		7.28E+02	4.31E+01	6.11E-01	5.11E-01	0.	0.	0.

AVERAGE PROJECTION RATIO — PRECIP PROBE — RAIN — 460.976 SECOND SAMPLE

		01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*		TOTAL 01-15
	01	58-1																(1 - 2)	58-1
M	02	34-1																(3 - 4)	34-1
A	03	27-1																(5 - 6)	27-1
X	04	18-1																(7 - 8)	18-1
I	05	17-1																(9 - 10)	13-1
M	06	96-2																(11 - 12)	96-2
U	07	73-2																(13 - 14)	73-2
M	08	69-2																(15 - 16)	69-2
	09	67-2																(17 - 18)	67-2
L	10	54-2																(19 - 20)	54-2
E	11	43-2																(21 - 22)	43-2
N	12	47-2																(23 - 24)	47-2
G	13	37-2																(25 - 26)	37-2
T	14	34-2																(27 - 28)	34-2
H	15	39-2																(29 - 30)	39-2
	16	34-1		74-2		21-3			11_3									(31 - 32)	36-1
		(1.0)	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(2.0)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)		
		(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(2.0)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)		

TOTAL	6.58E+01	0.	0.	0.	0.	0.	0.	0.
06-15		0.	0.	0.	0.	0.	0.	0.

Figure 22D: KNOLL2D Sample Output

PASS 1 DISTRIBUTION MATRICES

START 16:30:00
STOP 16:37:49

EQUIVALENT CIRCLE RATIO — CLOUD PROBE — RAIN — 416.979 SECOND SAMPLE

	01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	TOTAL 01-15
01	34+3																34+3
02	75+2	53+2	11+2	67+0	21-1												14+3
03	40+1	17+2	86+1	26+1	14+0	15-1											32+2
04	6*+0	92+1	74+1	30+1	48+0	32-1											21+2
05	19+0	56+1	49+1	13+1	76+0	60-1		44_2									12+2
06	11-1	19+1	26+1	67+0	19+0	31-1	47_2										55+1
07		67+0	16+1	58+0	94-1	46-1	13-1										70+1
08		25+0	78+0	29+0	75-1	11-1		47_2									14+1
09		75-1	27+0	98-1	55-1												49+0
10		14-1	73-1	12+0	61-1	19-1											28+0
11			84-1	54-1	17-1	21-1	10_1										19+0
12			87_2	43-1													56-1
13				12_1													12-1
14				87_2			10_1										19-1
15					20_1												20-1
16																	
	(1.0)	(1.2)	(1.4)	(1.6)	(1.8)	(2.0)	(2.2)	(2.4)	(2.6)	(2.8)	(3.0)	(3.2)	(3.4)	(3.6)	(3.8)	(4.0)	
	(1.2)	(1.4)	(1.6)	(1.8)	(2.0)	(2.2)	(2.4)	(2.6)	(2.8)	(3.0)	(3.2)	(3.4)	(3.6)	(3.8)	(4.0)	(4.2)	

(1 - 2) (3 - 4) (5 - 6) (7 - 8) (9 - 10) (11 - 12) (13 - 14) (15 - 16) (17 - 18) (19 - 20) (21 - 22) (23 - 24) (25 - 26) (27 - 28) (29 - 30) (31 - 32)

TAL 1.11E+00 5.40E+02 5.14E+01 3.80E+00 0. 0. 0. 0.
-15 2.94E+02 1.88E+02 1.30E+01 4.70E-01 0. 0. 0. 0.

EQUIVALENT CIRCLE RATIO — PRECIP PROBE — RAIN — 460.976 SECOND SAMPLE

	01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	TOTAL 01-15
01	58-1																58-1
02	18-1	16-1	11_3														34-1
03	21-3		26-1														27-1
04				18-1													18-1
05			11_3	75-2	54-2												13-1
06					53-2	43-2											96-2
07						73-2											73-2
08							69-2										69-2
09							40-2	26-2									67-2
10								54-2									54-2
11							11_3		42-2								43-2
12							11_3		25-2	20-2							47-2
13										37-2							37-2
14										19-2	15-2						34-2
15											39-2						39-2
16										32-2	11-2	45-2	34-2	54-2	26-2	18-1	17-1
	(1.0)	(1.2)	(1.4)	(1.6)	(1.8)	(2.0)	(2.2)	(2.4)	(2.6)	(2.8)	(3.0)	(3.2)	(3.4)	(3.6)	(3.8)	(4.0)	
	(1.2)	(1.4)	(1.6)	(1.8)	(2.0)	(2.2)	(2.4)	(2.6)	(2.8)	(3.0)	(3.2)	(3.4)	(3.6)	(3.8)	(4.0)	(4.2)	

(1 - 2) (3 - 4) (5 - 6) (7 - 8) (9 - 10) (11 - 12) (13 - 14) (15 - 16) (17 - 18) (19 - 20) (21 - 22) (23 - 24) (25 - 26) (27 - 28) (29 - 30) (31 - 32)

AL 0. 0. 5.23E-01 1.11E+00 6.77E-01 5.39E-01 0. 0.
-15 0. 0. 1.16E+00 8.03E-01 7.61E-01 0. 0. 0.

Figure 22E: KNOLL2D Sample Output

PASS 1 DISTRIBUTION MATRICES

START 16:30:00
STOP 16:37:49

EQUIVALENT CIRCLE RATIO — CLOUD PROBE — RAIN — 416.979 SECOND SAMPLE

		01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	TOTAL 01-15	
	01	11-1	29+1	29+1	20+0	17-1	17-1												(1.00 - 1.10)
A	02		13+0	24+1	74+0	45-1	61_2	47_2											(1.10 - 1.20)
V	03			25+0	70+0	17+0	26-1		47_2										(1.20 - 1.30)
E	04			14-1	22+0	15+0	26-1	20-1											(1.30 - 1.40)
	05				20-1	12+0	37-1	13-1											(1.40 - 1.50)
D	06						61_2												(1.50 - 1.60)
P	07					87_2	61_2												(1.60 - 1.70)
O	08					61_2													(1.70 - 1.80)
J	09					56_2	56_2												(1.80 - 1.90)
	10																		(1.90 - 2.00)
D	11																		(2.00 - 2.10)
A	12																		(2.10 - 2.20)
T	13																		(2.20 - 2.30)
I	14																		(2.30 - 2.40)
O	15																		(2.40 - 2.50)
	16																		(2.50 - 2.60)

(1.0) (1.2) (1.4) (1.6) (1.8) (2.0) (2.2) (2.4) (2.6) (2.8) (3.0) (3.2) (3.4) (3.6) (3.8) (4.0)
(1.2) (1.4) (1.6) (1.8) (2.0) (2.2) (2.4) (2.6) (2.8) (3.0) (3.2) (3.4) (3.6) (3.8) (4.0) (4.2)

TOTAL 01-15	1.11E+00	5.40E+02	5.14E+01	3.80E+00	0.
	2.64E+02	1.49E+02	1.30E+01	4.70E-01	0.

0.	0.	0.	0.
0.	0.	0.	0.

EQUIVALENT CIRCLE RATIO — PRECIP PROBE — RAIN — 460.976 SECOND SAMPLE

		01	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	TOTAL 01-15	
	01					57-2	12-1	11-1	80-2	68-2	78-2	64-2	44-2	34-2	53-2	26-2	17-1		(1.00 - 1.10)
A	02																		(1.10 - 1.20)
V	03										11_3		11_3		11_3		42-3		(1.20 - 1.30)
E	04																		(1.30 - 1.40)
	05																21-3		(1.40 - 1.50)
C	06																		(1.50 - 1.60)
P	07																		(1.60 - 1.70)
O	08																11_3		(1.70 - 1.80)
J	09																		(1.80 - 1.90)
	10																		(1.90 - 2.00)
P	11																		(2.00 - 2.10)
A	12																		(2.10 - 2.20)
T	13																		(2.20 - 2.30)
I	14																		(2.30 - 2.40)
O	15																		(2.40 - 2.50)
	16																		(2.50 - 2.60)

(1.0) (1.2) (1.4) (1.6) (1.8) (2.0) (2.2) (2.4) (2.6) (2.8) (3.0) (3.2) (3.4) (3.6) (3.8) (4.0)
(1.2) (1.4) (1.6) (1.8) (2.0) (2.2) (2.4) (2.6) (2.8) (3.0) (3.2) (3.4) (3.6) (3.8) (4.0) (4.2)

TOTAL 01-15	0.	0.	5.29E-01	1.11E+00	6.77E-01
	0.	0.	1.16E+00	8.03E-01	7.93E-01

6.45E-01	3.39E-01	2.64E-01	
4.55E-01	5.39E-01	1.82E+00	

Figure 22F: KNOLL2D Sample Output

DISTRIBUTION BY MAXIMUM LENGTH

---FLIGHT INFORMATION---
- 877-23 22 MAR 77 -

PARTICLE TYPES
CL: RAIN
PR: RAIN

470 SECOND PASS START 15:20:00
STOP 15:27:49

MS-20 PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER)

CH	//////C L O U D P R O B E////// **EQMD**	*NO-DENS*	** LWC **	////P R E C I P P R O B E//// **EQMD**	*NO-DENS*	** LWC **
1	58.0	6.955E+05	3.501E-03	46.3	1.460E+01	3.051E-04
2	107.2	2.809E+05	5.963E-03	857.8	8.670E+00	1.133E-03
3	156.9	6.522E+04	5.568E-03	1255.4	6.691E+00	2.761E-03
4	206.8	4.161E+04	9.605E-03	1654.1	4.610E+00	4.354E-03
5	256.7	2.468E+04	1.091E-02	2053.4	3.256E+00	5.835E-03
6	306.6	1.092E+04	8.235E-03	2452.8	2.409E+00	7.474E-03
7	356.6	5.977E+03	7.089E-03	2852.6	1.825E+00	8.956E-03
8	406.5	2.322E+03	4.961E-03	3252.3	1.719E+00	1.278E-02
9	456.5	9.869E+02	2.457E-03	3652.1	1.656E+00	1.699E-02
10	506.5	5.692E+02	1.976E-03	4052.0	1.348E+00	1.873E-02
11	556.5	3.729E+02	1.681E-03	4451.9	1.084E+00	2.007E-02
12	606.5	1.125E+02	6.570E-04	4851.9	1.163E+00	2.782E-02
13	656.5	2.444E+01	1.810E-04	5251.7	9.252E-01	2.806E-02
14	706.5	7.733E+01	3.491E-04	5651.7	8.459E-01	3.438E-02
15	756.5	4.077E+01	4.616E-04	6051.6	9.790E-01	4.533E-02
* (GM/M**3)		6.756E-02			2.322E-01	
* (MM**6/M**3)		4.734E+00			5.207E+04	
ND(M/CONS)		2.552E+02			4.899E+03	
W(M/S**.5)		3.095E-02			1.009E-03	
SAMPLE(SEC)		418.979			440.976	

			TOTAL
HEIGHT	(METERS)	8997.23	2.951E-01
PRESSURE	(MB-K)	707.84	5.298E+04
TEMPERATURE	(DEG C)	-41.83	4.284E+03
DEWPOINT	(DEG C)	-50.99	1.296E-03
C AIR SPEED	(M/SEC)	129.06	
T AIR SPEED	(M/SEC)	123.13	
JW-LWC	(GM/M**3)	-.01	

//// TOTAL COUNTS ////

	CLOUD REJ	CLOUD TOT	PRECIP REJ	PRECIP TOT
	8605	9130	132	132
	13707	15968	311	311
	6697	8123	252	252
	4307	5423	174	174
	2390	3098	123	123
	983	1761	91	91
	493	678	69	69
	215	294	65	65
	69	94	63	63
	36	47	51	51
	22	31	41	41
	6	10	44	44
	1	3	35	35
	2	4	32	32
	1	1	37	37

Figure 22G: KNOLL2D Sample Output

DISTRIBUTION BY HORIZONTAL FERET PROJECTION

470 SECOND PASS — START 15:30:00 — STOP 15:37:49

---FLIGHT INFORMATION---
- 577-23 — 22 MAR 77 -

PARTICLE TYPES
CL: RAIN
PR: RAIN

PMS-2D PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER)

CH	////CLOUD PROBE//// EQMD	NO-DENS	LWC	////PRECIP PROBE//// EQMD	NO-DENS	LWC
1	37.5	8.869E+05	1.224E-03	700.0	5.159E+01	2.919E-04
2	87.5	1.141E+05	2.002E-03	700.0	0.	0.
3	137.5	5.433E+04	3.698E-03	1100.0	0.	0.
4	187.5	3.378E+04	5.829E-03	1500.0	0.	0.
5	237.5	1.492E+04	5.157E-03	1900.0	0.	0.
6	287.5	6.378E+03	3.968E-03	2300.0	0.	0.
7	337.5	2.698E+03	2.706E-03	2700.0	0.	0.
8	387.5	1.039E+03	1.562E-03	3100.0	0.	0.
9	437.5	5.062E+02	1.110E-03	3500.0	0.	0.
10	487.5	1.629E+02	4.942E-04	3900.0	0.	0.
11	537.5	7.332E+01	2.981E-04	4300.0	0.	0.
12	587.5	0.	0.	4700.0	0.	0.
13	637.5	4.073E+01	2.767E-04	5100.0	0.	0.
14	687.5	0.	0.	5500.0	0.	0.
15	737.5	0.	0.	5900.0	0.	0.

HEIGHT	(METERS)	8987.23	
PRESSURE	(MB-X)	707.84	
TEMPERATURE	(DEG C)	-41.83	
DEWPOINT	(DEG C)	-50.99	
C AIR SPEED	(M/SEC)	126.06	
T AIR SPEED	(M/SEC)	123.17	
JW-LWC	(GM/M**3)	-.01	

//// TOTAL COUNTS ////

	CLOUD REJ	CLOUD TOT	PRECIP REJ	PRECIP TOT
	19582	21128	1856	1856
	7405	9791	0	0
	5557	6565	0	0
	3317	4019	0	0
	1334	1715	0	0
	522	667	0	0
	188	255	0	0
	58	78	0	0
	29	41	0	0
	8	13	0	0
	3	4	0	0
	0	1	0	0
	1	1	0	0
	0	1	0	0
	0	0	0	0

		TOTAL
M (GM/M**3)	2.838E-02	2.781E-02
Z (MM**6/M**3)	1.294E+00	1.069E+00
DD(MICRONS)	2.263E+02	2.236E+02
MM(M/Z**.5)	2.495E-02	2.630E-02
SAMPLE(SEC)	418.979	450.976

Figure 22H: KNOLL2D Sample Output

DISTRIBUTION BY AREA

70 SECOND PASS — START 15:30:00 — STOP 15:37:49

---FLIGHT INFORMATION---
- E77-23 — 22 MAR 77 -

PARTICLE TYPES
CL: RAIN
PP: RAIN

1S-2D PARTICLE SIZE DISTRIBUTIONS (NUMBER/M**3-MM EQUIVALENT MELTED DIAMETER)

CH	//////C L O U D P R O J E////// **EQMD**	*NO-DENS*	** LWC **	////P R E C I P P R O B E//// **EQMD**	*NO-DENS*	** LWC **
1	54.5	1.814E+05	7.825E-03	439.9	5.409E+01	4.672E-04
2	91.7	2.443E+05	1.294E-03	650.2	2.834E+01	6.149E-04
3	106.0	9.253E+04	1.265E-03	848.1	1.581E+01	8.848E-04
4	132.0	5.638E+04	1.740E-03	1055.8	1.021E+01	1.277E-03
5	164.1	3.751E+04	2.878E-03	1312.8	2.830E+00	8.603E-04
6	197.8	2.651E+04	2.473E-03	1582.4	0.	0.
7	228.3	1.157E+04	1.983E-03	1826.5	0.	0.
8	269.1	5.438E+03	1.520E-03	2079.1	0.	0.
9	289.7	2.764E+03	9.660E-04	2317.8	0.	0.
10	317.4	1.737E+03	7.160E-04	2538.8	0.	0.
11	348.6	6.766E+02	5.224E-04	2788.5	0.	0.
12	383.0	4.760E+02	4.437E-04	3063.7	0.	0.
13	414.5	2.777E+02	3.032E-04	3316.0	0.	0.
14	442.8	0.	0.	3543.3	0.	0.
15	471.3	0.	0.	3770.1	0.	0.

			TOTAL
* (GM/M**3)	1.333E-02	4.137E-03	2.233E-02
: (M**6/M**3)	3.891E-01	8.141E+00	8.326E+00
C (MICRONS)	1.687E+02	9.578E+02	1.878E+02
W (M/**.5)	3.135E-02	1.449E-03	7.737E-03
AMPLE(SEC)	418.979	460.376	

			REJ	TOT	REJ	TOT
HEIGHT	(METERS)	8987.23	19634	21591	587	587
PRESSURE	(MB-K)	307.84	6124	7661	404	404
TEMPERATURE	(DEG C)	-41.83	4142	5155	262	262
DEWPOINT	(DEG C)	-30.99	2966	3749	196	196
C AIR SPEED	(M/SEC)	126.03	2430	3146	159	159
T AIR SPEED	(M/SEC)	123.13	1122	1531	95	95
JW-LWC	(GM/M**3)	-.01	548	745	47	47
			266	379	40	40
			113	166	29	29
			60	78	8	11
			32	41	12	12
			17	21	8	8
			9	13	3	3
			0	3	2	2
			0	1	0	0

Figure 22I: KNOLL2D Sample Output

3.5 SDIODE

3.5.1 Program Description

Program SDIODE examines the data for hardware anomalies such as: a diode in the on or off state at all times, an incorrect time flag or time word. Large streakers that appear in the data record are also indicated. The technique utilized is similar to a longitudinal redundancy check used by most tape drive controllers.

Program SDIODE uses as its input the 9 track PMS-2D data acquisition tape as written by the on-board PERTEC recorder. The operating environment for SDIODE is from card input through the CDC 6600 batch processor.

3.5.2 Control Cards

```
JOB,CM60000,T400,NT1.                          ID          NAME
PAUSE, PLS MOUNT DISK LYCPFI
MOUNT,SN=LYCPFI,VSN=LYCPFI.
SETNAME(LYCPFI)
VSN,TAPE1=TAPENO/NT.
REQUEST,TAPE1,PE,L,NR,NT.
ATTACH,LGO,SDIODEBINX2497,ID=GLASS.
FILE(TAPE1,RT=U,BT=K,MRL=5470,MBL=5470,RB=1,BFS=549)
LDSET,FILES=TAPE2,PRESET=ZERO.
LGO.
```

3.5.3 Input Cards

NONE REQUIRED

3.5.4 Output Description

One line of output appears for each PMS-2D tape record. This line will contain 32 sums indicating the number of times, during that record, a particular diode was in the on state.

The sums for diode numbers 9 through 32 should be fairly random with values between 200 and 500. Excessively high or low values for a particular diode indicate a probable error. Diodes 1 through 8 should have values in the same range, however, there should be alternating high/low pattern to the eight sums. This pattern indicates the presence of a correct time flag.

4.1 SPANDAR

4.1.1 Program Description

Program SPANDAR takes the IBM 360 generated radar correlation tape and reformats it into a CDC 6600 SCOPE-NOS/BE compatible tape. SPANDAR can only be run under the CDC 6600 batch processor via card input.

Input is the radar data tape (Appendix 19) containing DBZ values generated during an aircraft sampling pass in Wallops Island vicinity. It is processed by the Applied Physics Lab at Johns Hopkins University before being sent to AFGL/LYC.

There are five different output options available from SPANDAR:

1) line printer plot of Z	TAPE2
2) CDC 6600 data tape	TAPE3
3) data summary printout	TAPE7
4) tape listing (formatted)	TAPE8
5) punched cards	TAPE4

4.1.2 Control Cards

```
JOBNM,CM65000,T50,TP2.*                PROB NO.      NAME
REQUEST,TAPE1,L,MT,VSN=TAPENO.   (7 TRACK - NO RING)
REQUEST,TAPE3,MT,RING,VSN=TAPENO.*   (7 TRACK - RING)
ATTACH,LGO,SPANDARBIN,ID=GLASS,MR=1.
FILE(TAPE1,RT=U,BT=K,MRL=5339,MBL=5339,RB=1,BFS=536)
MAP,OFF
LDSET,FILES=TAPE1,PRESET=ZERO.
LGO.
REWIND,TAPE8.
COPY,TAPE8.                    FOR TAPE LISTING
REWIND,TAPE2.
COPY,TAPE2.                    FOR LINE PRINTER PLOT
REWIND,TAPE4.
COPY,TAPE4.                    FOR PUNCHED CARDS
6/7/8/9
```

* FOR NO OUTPUT TAPE REMOVE REQUEST,TAPE3,... CARD AND CHANGE TP2 TO TP1

4.1.3 Data Cards

NONE REQUIRED

4.1.4 Output Description

The standard SPANDAR output format is a summary of all the data on the converted tape. The page headings specify which aircraft the radar was tracking and each block underneath specifies one correlated radar-aircraft track. For instance, in figure 23A the C130 aircraft was tracked on 22 MAR 77 from 14:15:54 until 14:16:33 at an average height of 1400 feet. This track is referenced as pass 3.

Optional TAPE8 (figure 23B) output is a complete listing of every item on the data tape. On the top of each page is an expansion of the pass summary block. listing aircraft and times. The rest of the page is devoted to the tabular values given on the radar tape:

HH:MM:SS.F	time sample was collected (once a second)
Z(DBZ)	radar reflectivity
EL(DEG)	radar elevation in degrees
AZ(DEG)	azimuth in degrees
RSLRA(NM)	slant range to the aircraft in nautical miles
GRRA(NM)	ground distance to the aircraft in nautical miles
GR RA(KM)	altitude in kilometer

Optional output TAPE2 is a line printer plot figure 23C of radar reflectivity (Z) vs. time. The range of Z is -25.0 DBZ to +25.0 DBZ in increments of .5 DBZ. The program divides the data into one minute groups with a series of bars, but does not cause a break in the graph. The time, the slant rante, and the value of Z are printed to the side of each point plotted.

Figure 23A: SPANDAR Sample Output

```
                    0130                LEAR
                    ******              ******

1       DATE  22 MAR 77
        PASS     3
        FROM  14:15:54.0
          TO  14:16:33.0
          HT   1400.0 FT

2       DATE  22 MAR 77
        PASS     5
        FROM  14:18:39.0
          TO  14:19:16.0
          HT   1200.0 FT

3       DATE  22 MAR 77
        PASS     5
        FROM  14:34:14.0
          TO  14:34:28.0
          HT   4800.0 FT

4       DATE  22 MAR 77
        PASS     5
        FROM  14:34:34.0
          TO  14:35:19.0
          HT   4800.0 FT

5       DATE  22 MAR 77
        PASS     5
        FROM  14:35:24.0
          TO  14:35:37.0
          HT   4800.0 FT

6       DATE  22 MAR 77
        PASS     5
        FROM  14:35:42.0
          TO  14:37:58.0
          HT   4800.0 FT

7       DATE  22 MAR 77
        PASS     7
        FROM  14:57: 5.0
          TO  14:58: 2.0
          HT   1300.0 FT

8       DATE  22 MAR 77
        PASS     7
        FROM  14:58: 7.0
          TO  14:58:17.0
          HT   1700.0 FT
```

22 MAR 77 C130 PASS 3 1400.00 FT SCAN 5
40 SECONDS FROM 14:15:38.4 TO 14:16:18.4

HH:MN:SC.F	Z(DBZ)	EL (DEG)	AZ (DEG)	RSLRA (NM)	GR RA (NM)	GR RA (KM)	ALT (FT)	ALT (KM)
14:15:54.0	17.3	1.1	100.9	11.0	11.0	20.3	1362.6	.4
14:15:55.0	16.9	1.1	100.9	10.9	10.9	20.2	1352.0	.4
14:15:56.0	17.4	1.1	100.9	10.8	10.8	20.0	1341.4	.4
14:15:57.0	17.7	1.1	100.9	10.8	10.8	20.0	1341.4	.4
14:15:58.0	18.4	1.2	100.9	10.8	10.8	19.9	1481.3	.5
14:15:59.0	18.1	1.2	101.0	10.8	10.8	19.9	1481.3	.5
14:16: 0.0	18.0	1.2	101.0	10.7	10.7	19.7	1468.6	.4
14:16: 1.0	17.7	1.2	101.0	10.6	10.6	19.6	1457.9	.4
14:16: 2.0	17.9	1.2	101.1	10.6	10.6	19.6	1457.9	.4
14:16: 3.0	17.4	1.2	101.1	10.5	10.5	19.4	1446.2	.4
14:16: 4.0	16.2	1.2	101.2	10.4	10.4	19.3	1434.5	.4
14:16: 5.0	16.5	1.2	101.2	10.4	10.4	19.3	1434.5	.4
14:16: 6.0	16.5	1.2	101.3	10.4	10.4	19.1	1422.9	.4
14:16: 7.0	16.3	1.2	101.4	10.4	10.4	19.1	1422.9	.4
14:16: 8.0	15.4	1.2	101.4	10.3	10.3	19.0	1411.2	.4
14:16: 9.0	15.5	1.2	101.4	10.2	10.2	18.9	1399.5	.4
14:16:10.0	15.2	1.2	101.5	10.2	10.2	18.9	1399.5	.4
14:16:11.0	15.0	1.2	101.5	10.1	10.1	18.7	1387.9	.4
14:16:12.0	15.2	1.2	101.5	10.0	10.0	18.6	1376.2	.4
14:16:13.0	15.3	1.2	101.6	10.0	10.0	18.6	1376.2	.4
14:16:14.0	15.2	1.2	101.6	9.9	9.9	18.4	1364.6	.4
14:16:15.0	15.1	1.3	101.7	9.9	9.9	18.4	1457.4	.4
14:16:16.0	14.4	1.3	101.7	9.9	9.9	18.3	1445.0	.4
14:16:17.0	15.7	1.3	101.8	9.8	9.8	18.1	1432.6	.4
14:16:18.0	15.0	1.3	101.8	9.8	9.8	18.1	1432.6	.4
14:16:19.0	15.1	1.3	101.9	9.7	9.7	18.0	1420.3	.4
14:16:20.0	14.8	1.3	102.0	9.7	9.7	18.0	1420.3	.4
14:16:21.0	16.5	1.2	102.0	9.7	9.7	18.0	1323.8	.4
14:16:22.0	15.5	1.2	102.1	9.6	9.6	17.8	1313.2	.4
14:16:23.0	15.0	1.2	102.1	9.6	9.6	17.8	1313.2	.4
14:16:24.0	14.8	1.2	102.1	9.5	9.5	17.7	1306.6	.4
14:16:25.0	14.2	1.2	102.2	9.5	9.5	17.5	1295.0	.4
14:16:26.0	14.1	1.3	102.2	9.5	9.5	17.5	1383.2	.4
14:16:27.0	13.7	1.3	102.4	9.4	9.4	17.4	1370.9	.4
14:16:28.0	13.5	1.3	102.4	9.3	9.3	17.2	1358.6	.4
14:16:29.0	13.7	1.3	102.4	9.3	9.3	17.2	1358.6	.4
14:16:30.0	13.3	1.3	102.4	9.2	9.2	17.1	1346.3	.4
14:16:31.0	13.4	1.3	102.4	9.2	9.2	17.1	1346.3	.4
14:16:32.0	12.7	1.3	102.5	9.1	9.1	16.9	1334.0	.4
14:16:33.0	12.8	1.3	102.4	9.1	9.1	16.8	1321.7	.4

Figure 23B: SPANDAR Sample Output

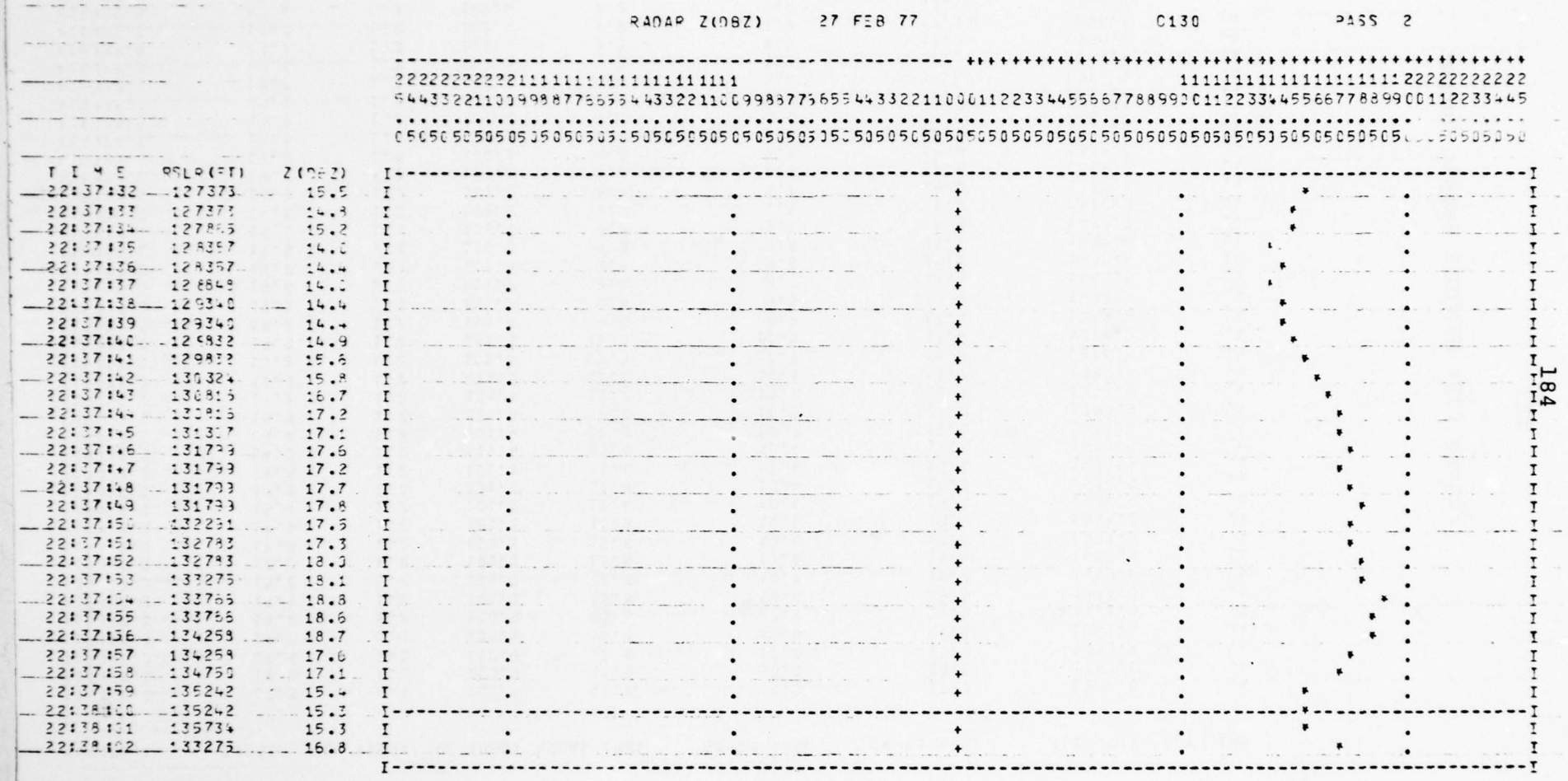


Figure 23C: SPANDAR Sample Output

4.2 MORT

4.2.1 Program Description

Program MORT reformats the radar correlation tape produced at the Kwajalein Missile Range. This tape actually contains data from two different radar sources (ALCOR and TRADEX). The output format is similar to that produced by program SPANDAR. This permits data from either Wallops or Kwajalein to be used interchangeably by program RAPP. Program MORT must be run through the CDC 6600 batch processor. The input file description may be found in Appendix 22, MORT input format. In addition to the output tape, a complete tape listing is also produced. The output file description is of course, identical to the RAPP input tape (Appendix 23).

4.2.2 Control Cards

```
JOBNM,CM65000,T100,TP2.*                ACT.          NAME
REQUEST,TAPE1,MT,VSN=TAPENO.   (7 TRACK - NO RING)
REQUEST,TAPE3,MT,RING,VSN=TAPENO.*   (7 TRACK - RING)
ATTACH LGO,MORTBIN,ID=GLASS,MR=1.
MAP,OFF.
LGO.
7/8/9
6/7/8/9
```

* IF AN OUTPUT TAPE IS NOT NEEDED CHANGE TP2 TO TP1 AND REMOVE REQUEST,TAPE3,... CARD

4.2.3 Data Card

NONE REQUIRED

4.3 MORTDUMP/TTYMORT

4.3.1 Program Description

As a result of problems trying to read KREMS tapes from Kwajalein, program MORTDUMP was written to copy these radar correlation tapes to disk. Once on the disk the INTERCOM text editor is used to correct the errors manually. After the errors are corrected program TTYMORT is used to format the data tape as if it had been processed by program MORT. Only the operating instructions are included here, for a description of how TTYMORT operates refer to program MORT (Section 4.2). TTYMORT performs the same function, but only from the terminal under INTERCOM.

4.3.2 Control Cards

```
JOBNM,CM65000,T20,TP1.                PROB#          NAME
REQUEST,TAPE3,*PF.
REQUEST,TAPE1,MT,VSN=TAPENO.          (7 TK NORING)
ATTACH LGO,MORTDUMPBIN,ID=GLASS.
LGO.
CATALOG,TAPE3,KREMS,ID=FRANCIS
6/7/8/9
```

At this point manually edit the data on INTERCOM by:

```
ATTACH,TAPE,KREMS,ID=FRANCIS↓
REQUEST,TAPE2,*PF↓
EDITOR↓
E TAPE S↓
[EDIT OUT THE ERRORS]
S TAPE1 O N↓
ATTACH,LGO,TTYMORTBIN,ID=FRANCIS↓
LGO↓
CATALOG,TAPE2,RAPPTAPE,ID=FRANCIS↓
```

After TAPE2 has been catalogued, it is now ready for standard processing with program RAPP.

4.4 RAPP

4.4.1 Program Description

Program RAPP correlates data collected from the PMS 1D and 2D devices aboard the C130-E or the LEARJET with data acquired from a ground based radar. The correlated data is then plotted in a variety of ways:

1) aircraft "MK" vs. radar "Z"
2) aircraft "Z" vs. aircraft "M"
3) aircraft "Z" and aircraft "M" vs. time
4) aircraft "Z" and radar "Z" vs. time
5) aircraft "MK" and radar "Z" vs. time
6) aircraft "Z" vs. radar "Z"
7) aircraft "M" vs. radar "Z"

M is liquid water content GM/M**3
Z is radar reflectivity
MK is defined as $1000*M/\sqrt{Z}$

There are two tape inputs to RAPP, TAPE7 produced by KNOLL1D and TAPE3 produced by either SPANDAR, MORT or TTYMORT. Since RAPP requires tape input it must be run from cards in batch mode.

The output listing consists of tabulated data points, correlation percentages for shifts of aircraft-radar matchings of ± 3 seconds, and least square regression coefficients for plots 1,2,6,7 listed above. The graphical output uses 35mm film generated by a CALCOMP CRT plotter.

4.4.2 Control Cards

```
JOBNM,CM67000,T200,TP2.                ACT.      NAME
REQUEST,TAPE1,MT,VSN=TAPENO.           (7 TK-NORING)(FROM KNOLL1D)
REQUEST,TAPE3,MT,VSN=TAPENO.           (7 TK-NORING)(FROM SPANDAR)
ATTACH,LGO,RAPPBIN,ID=GLASS,MR=1.
ATTACH,CRT,OFFLINECRT.
LIBARARY(CRT)
REQUEST,TAPE39,*Q.
DISPOSE,TAPE39,*FL.
LDSET,PRESET=ZERO.
LGO.
7/8/9
-DATA CARDS-
6/7/8/9
```

AD-A064 781 DIGITAL PROGRAMMING SERVICES INC WALTHAM MASS F/G 4/2
DEVELOPMENT AND APPLICATION OF MATHEMATICAL PROCEDURES TO A VAR--ETC(U)
JUN 78 L E BELSKY, M W FRANCIS, F B KAPLAN F19628-76-C-0241

UNCLASSIFIED AFGL-TR-78-0170 NL

3 OF 3
AD
A064781

END
DATE
FILMED
4-79
DDC

4.4.3 Data Cards

card 1

cc 1-6	MISSION ID (XYR-NN)
cc 8-13	A/C TYPE E.G. C130-X
cc 15-24	FLIGHT DATE DD MON YR (LJ)
cc 25	PROBE 1 SCATTER 2 CLOUD 3 PRECIP 4 TOTAL (CLOUD+PRECIP)
cc 31-40	RADAR OFFSET (METERS) F10.0
cc 41-50	RADAR CORRECTION F10.1
cc 55	KWAJ (1-IF KWAJALEIN FLIGHT 0-OTHERWISE) - SEE BELOW
cc 56-65	DB1 (MINIMUM RADAR DETECTABLE CONSTANT) F10.0 DBZ MINIMUM AT 1 KILOMETER
cc 70	IQUIP = 1 FOR 1D DATA(DEFAULT) 2 FOR 2D DATA

cards 2-N+1 (FOR N PASSES)

PASS BEGINNING, ENDING CARDS
FOR EACH DESIRED PASS, ENTER CARD:

cols 1-2	PASS NUMBER
cols 4-9	BEGIN PASS TIME, AS HHMMSS
cols 11-16	END PASS TIME, AS HHMMSS

NOTE: TIMES ARE AIRCRAFT TIMES IF IRADAR=0,
THEY ARE RADAR TIMES IF IRADAR=1

cols 17	I IF ICE IN PASS; W IF WATER IN PASS
cols 20-29	MINIMUM M VALUE (LWC) (F10.0)
cols 30-39	MAXIMUM M VALUE (LWC IN GRAMS/M**3) (F10.0)
col 45	RADAR TYPE 0 SPANDAR(DEFAULT) 1 ALCOR (KWAJ MUST=1 ON HEADER CARD) 2 TRADEX (KWAJ MUST=1 ON HEADER CARD)

4.4.4 RAPP Output Description

The first page of a RAPP output (figure 24A) gives the aircraft and flight identification along with the time and date of processing.

The second page (figure 24B) is a pass summary. It specifies the pass number, actual start and stop time, crystal type for the pass and the average height as determined by the radar.

The first analysis section (figure 24C) is the aircraft derived data. The probe from which the data is generated is listed on the first line. The first column is the time of the sample. The columns labelled "AVE Z" and "AVE M" are the data points as calculated and averaged by KNOLL1D. The columns labelled "M", "Z" and "MK" are the values interpolated by Newton's Fundamental Formula. They represent LWC, radar reflectivity and K factor.

The next section (figure 24D) is simply a listing of the radar tape (Appendix 23). The additional value "DBZMIN" is the minimum detectable radar signal at 1 nautical mile. Any DBZ value below this value will be rejected.

The last two output pages (figure 24E & 24F) are the correlation summary. The first section lists what data correlation result from shifting the data $\pm$3 seconds. In this example the best correlation is no shift. As each plot is made the following parameters are printed.

1) the plot being made
2) the number of prints curve was fit to
3) the x and y log mean and standard deviation
4) the regression on x and the on y, with coefficients
5) the regression with the lowest RMS is printed as the one used
6) the correlation of the data

Figure 24A: RAPP Sample Output

```
;  9 HAS AIRCRAFT MOVING AT  120.0 METERS/SECOND
\R TIME INTERVAL IS (15:25:41,15:27:38)
 AIRCRAFT TIME IS OFFSET BY  0 SECONDS,  MAKING THE AIRCRAFT INTERVAL  (15:25:41,15:27:38)
:IPITATION IS IN THE FORM OF ICE      THE MINIMUM ACCEPTABLE LWC IS    1.000E-10 GRAMS/METER**3        AVERAGE HEIGHT IS    16585.
.....

; 10 HAS AIRCRAFT MOVING AT  120.0 METERS/SECOND
.R TIME INTERVAL IS (15:27:44,15:29:58)
 AIRCRAFT TIME IS OFFSET BY  0 SECONDS,  MAKING THE AIRCRAFT INTERVAL  (15:27:44,15:29:58)
:IPITATION IS IN THE FORM OF ICE      THE MINIMUM ACCEPTABLE LWC IS    1.000E-10 GRAMS/METER**3        AVERAGE HEIGHT IS    16811.
.....
```

Figure 24B: RAPP Sample Output

DATE 77/03/22 A/C DATA PASS 9 TOTAL PAGE 1

TIME	AVE Z GM/M**6/M**3	Z GM/M**6/M**3	AVE M GM/M**3	M GM/M**3	MK
15-25-41	3.778E-01	1.232E-01	5.714E-03	5.988E-03	1.944E+01
15-25-42		2.617E-01		5.996E-03	1.172E+01
15-25-43		5.516E-01		5.549E-03	7.478E+00
15-25-44		1.204E+00		5.539E-03	5.049E+00
15-25-45	1.004E+01	2.732E+00	7.679E-03	5.964E-03	3.608E+00
15-25-46		6.444E+00		5.926E-03	2.729E+00
15-25-47		1.578E+01		3.676E-03	2.184E+00
15-25-48		4.016E+01		1.172E-02	1.850E+00
15-25-49	4.898E+02	2.012E+02	3.463E-02	2.564E-02	1.608E+00
15-25-50		7.927E+02		3.245E-02	1.638
15-25-51		5.653E+02		3.567E-02	1.499E+00
15-25-52		6.032E+02		3.405E-02	1.387E+00
15-25-53	1.877E+02	2.956E+02	1.636E-02	2.010E-02	1.169E+00
15-25-54		2.211E+02		1.735E-02	1.167E+00
15-25-55		1.573E+02		1.558E-02	1.243E+00
15-25-56		1.053E+02		1.457E-02	1.413E+00
15-25-57	3.206E+01	7.391E+01	1.468E-02	1.427E-02	1.661E+00
15-25-58		4.331E+01		1.440E-02	2.189E+00
15-25-59		2.320E+01		1.509E-02	3.133E+00
15-26-00		1.134E+01		1.640E-02	4.871E+00
15-26-01	1.271E+00	3.759E+00	2.373E-02	2.817E-02	1.453E+01
15-26-02		1.794E+00		2.633E-02	1.966E+01
15-26-03		9.154E-01		2.040E-02	2.133E+01
15-26-04		4.936E-01		1.311E-02	1.854E+01
15-26-05	1.475E-01	3.482E-01	1.907E-03	4.137E-03	7.010E+00
15-26-06		1.977E-01		2.413E-03	5.426E+00
15-26-07		1.093E-01		1.542E-03	4.664E+00
15-26-08		5.875E-02		1.079E-03	4.453E+00
15-26-09	1.105E-02	1.156E-02	6.597E-04	7.237E-04	6.732E+00
15-26-10		9.910E-03		6.532E-04	6.562E+00
15-26-11		1.393E-02		6.939E-04	5.879E+00
15-26-12		3.211E-02		8.674E-04	4.841E+00
15-26-13	2.251E+00	9.052E-01	3.091E-03	2.334E-03	2.599E+00
15-26-14		1.818E+00		2.929E-03	2.172E+00
15-26-15		2.448E+00		3.135E-03	2.003E+00
15-26-16		1.958E+00		2.863E-03	2.040E+00
15-26-17	1.194E-01	1.925E-01	1.137E-03	1.395E-03	3.180E+00
15-26-18		1.298E-01		1.190E-03	3.316E+00
15-26-19		1.202E-01		1.112E-03	3.207E+00
15-26-20		1.554E-01		1.138E-03	2.877E+00
15-26-21	1.293E+00	5.857E-01	1.793E-03	1.392E-03	1.819E+00
15-26-22		1.007E+00		1.630E-03	1.625E+00
15-26-23		1.639E+00		1.994E-03	1.558E+00
15-26-24		2.527E+00		2.549E-03	1.603E+00
15-26-25	5.898E+00	9.312E+00	5.703E-03	5.582E-03	1.829E+00
15-26-26		7.858E+00		3.982E-03	2.133E+00
15-26-27		3.845E+00		5.145E-03	2.624E+00
15-26-28		1.037E+00		3.551E-03	3.406E+00
15-26-29	4.204E-03	2.051E-02	5.367E-04	8.081E-04	5.643E+00
15-26-30		6.131E-03		5.772E-04	7.372E+00
15-26-31		3.352E-03		5.317E-04	9.184E+00
15-26-32		3.352E-03		5.317E-04	1.091E+01
15-26-33	4.702E-02	2.109E-02	2.958E-03	2.219E-03	1.528E+01
15-26-34		3.649E-02		2.817E-03	1.475E+01
15-26-35		5.975E-02		2.963E-03	1.212E+01

Figure 24C: RAPP Sample Output

DATA -- PASS NO. 9

DBZ IS MODIFIED BY-ADDING 6.50

HR	MIN	SEC	RANGE	AZM	EL	ALT	DBZ	DBZMIN
15	25	41.000	72863.	99.141	1.011	1602.	-1.3	-56.2
15	25	42.000	73013.	99.141	1.011	1606.	-1.5	-56.2
15	25	43.000	73163.	99.009	1.011	1609.	-1.1	-56.2
15	25	44.000	73163.	99.009	1.011	1609.	-1.1	-56.2
15	25	45.000	73312.	99.009	1.011	1613.	-1.9	-56.2
15	25	46.000	73462.	99.009	1.011	1617.	-1.9	-56.2
15	25	47.000	73462.	99.009	1.011	1617.	-1.4	-56.2
15	25	48.000	73611.	99.009	1.011	1621.	-1.4	-56.2
15	25	49.000	73611.	98.921	1.011	1621.	-1.2	-56.2
15	25	50.000	73611.	98.921	1.011	1621.	-1.2	-56.2
15	25	51.000	73761.	98.833	1.011	1625.	-.9	-56.1
15	25	52.000	73761.	98.833	1.011	1625.	-1.0	-56.1
15	25	53.000	73911.	98.833	1.011	1629.	-.8	-56.1
15	25	54.000	74060.	98.745	1.011	1633.	-.1	-56.1
15	25	55.000	74060.	98.745	1.011	1633.	-.1	-56.1
15	25	56.000	74210.	98.745	1.011	1637.	.5	-56.1
15	25	57.000	74210.	98.613	1.011	1637.	2.0	-56.1
15	25	58.000	74359.	98.525	1.011	1641.	2.1	-56.1
15	25	59.000	74509.	98.525	1.011	1645.	1.1	-56.1
15	26	0.000	74509.	98.525	1.011	1645.	1.1	-56.1
15	26	1.000	74659.	98.438	1.011	1649.	1.8	-56.0
15	26	2.000	74808.	98.438	1.011	1653.	2.4	-56.0
15	26	3.000	74808.	98.350	1.011	1653.	1.9	-56.0
15	26	4.000	74958.	98.350	1.011	1657.	1.5	-56.0
15	26	5.000	74958.	98.350	1.011	1657.	.6	-56.0
15	26	6.000	75108.	98.218	1.011	1661.	.8	-56.0
15	26	7.000	75257.	98.218	1.011	1665.	.7	-56.0
15	26	8.000	75257.	98.218	1.011	1665.	.3	-56.0
15	26	9.000	75407.	98.130	1.011	1669.	0.0	-56.0
15	26	10.000	75556.	98.042	1.011	1673.	-.5	-55.9
15	26	11.000	75556.	98.042	1.011	1673.	-.5	-55.9
15	26	12.000	75556.	98.042	1.011	1673.	-.5	-55.9
15	26	13.000	75706.	98.042	1.011	1677.	-.9	-55.9
15	26	14.000	75706.	97.954	1.011	1677.	-1.3	-55.9
15	26	15.000	75856.	97.954	1.011	1681.	-1.4	-55.9
15	26	16.000	75856.	97.954	1.011	1681.	-1.3	-55.9
15	26	17.000	76005.	97.954	1.011	1685.	-.9	-55.9
15	26	18.000	76157.	97.822	.923	1572.	-1.9	-55.9
15	26	19.000	76157.	97.822	.923	1572.	-1.5	-55.9
15	26	20.000	76306.	97.822	.923	1576.	-1.7	-55.8
15	26	21.000	76456.	97.822	.923	1579.	-2.0	-55.8
15	26	22.000	76454.	97.734	1.011	1697.	-2.0	-55.8
15	26	23.000	76604.	97.734	1.011	1701.	-2.5	-55.8
15	26	24.000	76604.	97.646	1.011	1701.	-2.2	-55.8
15	26	25.000	76755.	97.646	.923	1587.	-2.1	-55.8
15	26	26.000	76905.	97.646	.923	1591.	-2.3	-55.8
15	26	27.000	76905.	97.646	.923	1591.	-2.1	-55.8
15	26	28.000	77055.	97.559	.923	1594.	-2.1	-55.8
15	26	29.000	77204.	97.559	.923	1598.	-2.4	-55.7
15	26	30.000	77204.	97.559	.923	1598.	-1.6	-55.7
15	26	31.000	77354.	97.427	.923	1602.	-2.1	-55.7
15	26	32.000	77354.	97.427	.923	1602.	-2.4	-55.7
15	26	33.000	77354.	97.339	.923	1602.	-2.6	-55.7
15	26	34.000	77503.	97.339	.923	1606.	-2.0	-55.7
15	26	35.000	77503.	97.339	.923	1606.	-2.4	-55.7
15	26	36.000	77653.	97.339	.923	1609.	-2.4	-55.7

Figure 24D: RAPP Sample Output

```
                    ****************************************
                    * CORRELATION AND PLOTTING FOR PASS  9 *
 ****************************************************************************************************

 AIRCRAFT DELAY OF 3 SECONDS, WITH A CORRELATION OF   31.4555 PERCENT
 AIRCRAFT DELAY OF 2 SECONDS, WITH A CORRELATION OF   38.1044 PERCENT
 AIRCRAFT DELAY OF 1 SECONDS, WITH A CORRELATION OF   44.5473 PERCENT
                  INPUT DATA  HAS CORRELATION OF   50.9000 PERCENT
   RADAR DELAY OF 1 SECONDS, WITH A CORRELATION OF   31.4555 PERCENT
   RADAR DELAY OF 2 SECONDS, WITH A CORRELATION OF   25.6803 PERCENT
   RADAR DELAY OF 3 SECONDS, WITH A CORRELATION OF   20.2863 PERCENT

 OPTIMIZATION OCCURS WITHOUT AN APPLIED DELAY
 ----------------------------------------------------------------------------------------------------

 PLOT RADAR Z VERSUS K
 118 POINTS FROM 118 WERE WITHIN PLOT LIMITS
 NUMBER OF POINTS USED FOR L.S. FIT IS 118
 RADAR Z   HAS A LOG MEAN OF  -1.541E-01 AND A DEVIATION OF   1.235E-01
 1000*K    HAS A LOG MEAN OF   7.242E-01 AND A DEVIATION OF   3.606E-01

 WITH 1000*K   AS A FUNCTION OF RADAR Z , THE SLOPE IS  5.220E-02, THE INTERCEPT IS  7.323E-01, AND HAS AN RMS OF  3.607E-01

 WITH RADAR Z  AS A FUNCTION OF 1000*K  , THE SLOPE IS  1.634E+02, THE INTERCEPT IS  2.589E+01, AND HAS AN RMS OF  1.235E-01

 COMBINATION USED IS RADAR Z  BEING A FUNCTION OF  1000*K
 WITH A CORRELATION OF   1.7875 PERCENT
 ----------------------------------------------------------------------------------------------------

 PLOT A/C M  VS.  A/C Z
 NUMBER OF POINTS USED FOR L.S. FIT IS 118
 A/C Z     HAS A LOG MEAN OF  -2.404E-01 AND A DEVIATION OF   1.228E+00
 A/C M     HAS A LOG MEAN OF  -2.396E+00 AND A DEVIATION OF   4.661E-01

 WITH A/C M    AS A FUNCTION OF A/C Z   , THE SLOPE IS  3.078E-01, THE INTERCEPT IS -2.322E+00, AND HAS AN RMS OF  2.728E-01

 WITH A/C Z    AS A FUNCTION OF A/C M   , THE SLOPE IS  4.682E-01, THE INTERCEPT IS -2.283E+00, AND HAS AN RMS OF  7.187E-01

 COMBINATION USED IS A/C M    BEING A FUNCTION OF  A/C Z
 WITH A CORRELATION OF  81.0799 PERCENT
 ----------------------------------------------------------------------------------------------------

 PLOT RADAR Z AND AIRCRAFT Z  VS. TIME
 ----------------------------------------------------------------------------------------------------

 PLOT RADAR Z AND AIRCRAFT K VS. TIME
 ----------------------------------------------------------------------------------------------------

 PLOT RADAR Z AND AIRCRAFT M  VS. TIME
 ----------------------------------------------------------------------------------------------------

 PLOT A/C Z  VS.  RADAR Z
 NUMBER OF POINTS USED FOR L.S. FIT IS 118
 RADAR Z   HAS A LOG MEAN OF  -1.541E-01 AND A DEVIATION OF   1.235E-01
 A/C Z     HAS A LOG MEAN OF  -2.404E-01 AND A DEVIATION OF   1.228E+00

 WITH A/C Z    AS A FUNCTION OF RADAR Z , THE SLOPE IS  3.127E+00, THE INTERCEPT IS  2.413E-01, AND HAS AN RMS OF  1.166E+00

 WITH RADAR Z  AS A FUNCTION OF A/C Z   , THE SLOPE IS  3.160E+01, THE INTERCEPT IS  4.628E+00, AND HAS AN RMS OF  1.173E-01

 COMBINATION USED IS RADAR Z  BEING A FUNCTION OF  A/C Z
 WITH A CORRELATION OF  31.4555 PERCENT
```

Figure 24E: RAPP Sample Output

```
A/C M  VS.  RADAR Z
ER OF POINTS USED FOR L.S. FIT IS 101
R Z  HAS A LOG MEAN OF  -1.460E-01 AND A DEVIATION OF    1.257E-01
Z    HAS A LOG MEAN OF  -2.269E+00 AND A DEVIATION OF    3.748E-01

A/C Z     AS A FUNCTION OF RADAR Z , THE SLOPE IS  1.374E+00, THE INTERCEPT IS -2.068E+00, AND HAS AN RMS OF  3.327E-01

RADAR Z   AS A FUNCTION OF A/C Z    , THE SLOPE IS  6.475E+00, THE INTERCEPT IS -1.323E+00, AND HAS AN RMS OF  1.116E-01

INATION USED IS RADAR Z  BEING A FUNCTION OF  A/C Z
A CORRELATION OF  46.0591 PERCENT
-------------------------------------------------------------------------------------------
```

Figure 24F: RAPP Sample Output

Figure 25A: RAPP Sample Plots

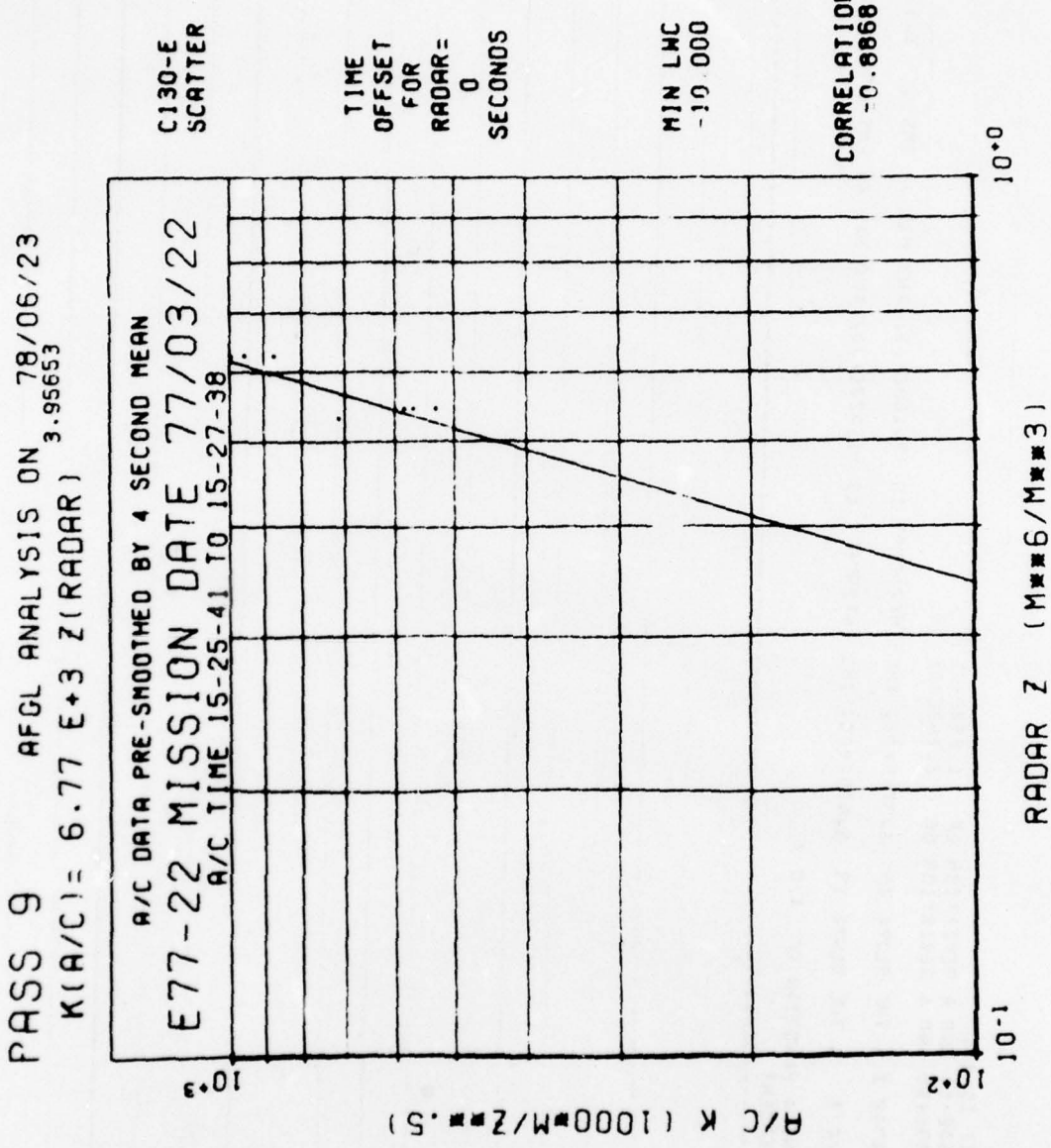


Figure 25B: RAPP Sample Plots

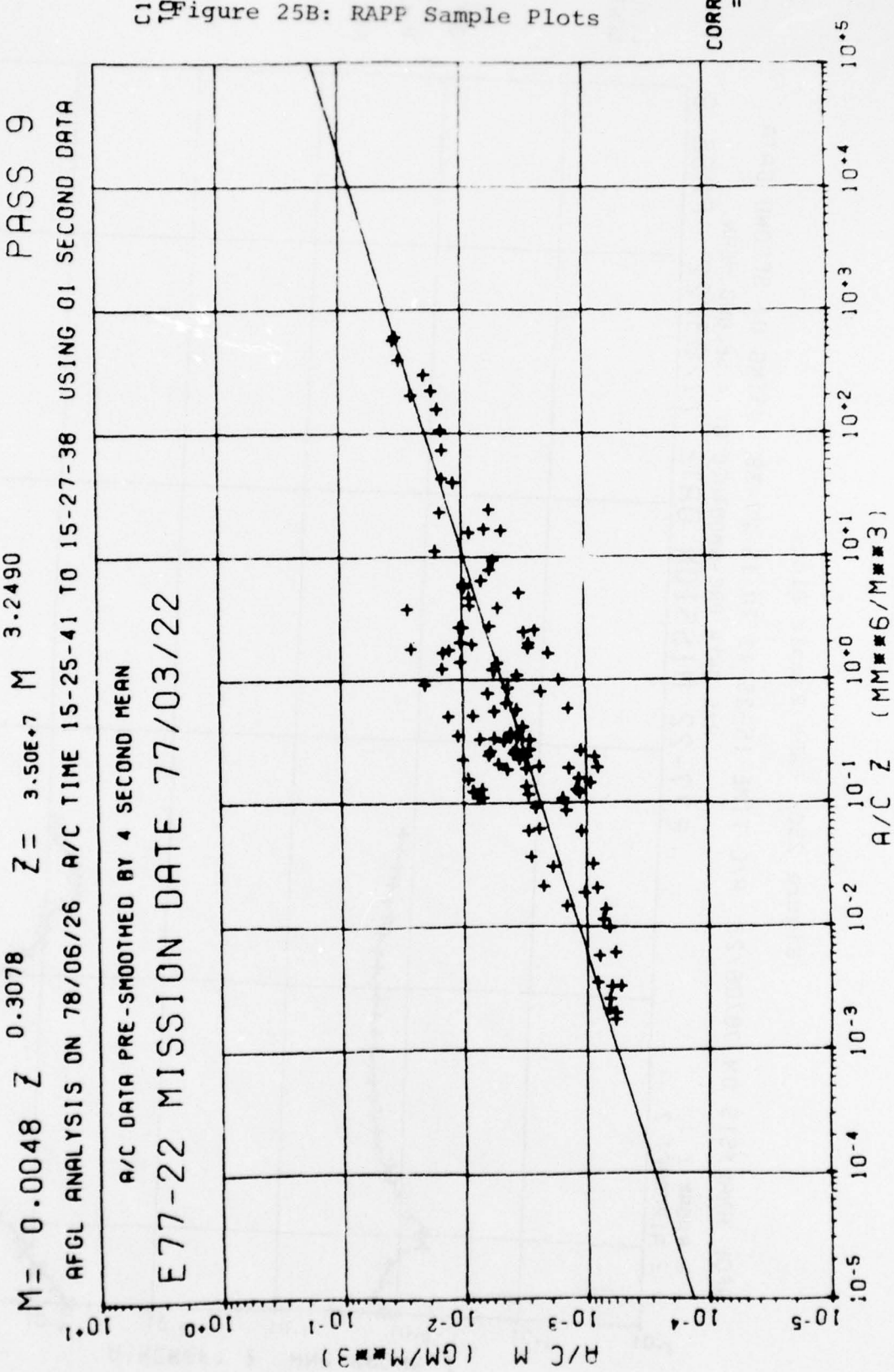


Figure 25C: RAPP Sample Plots

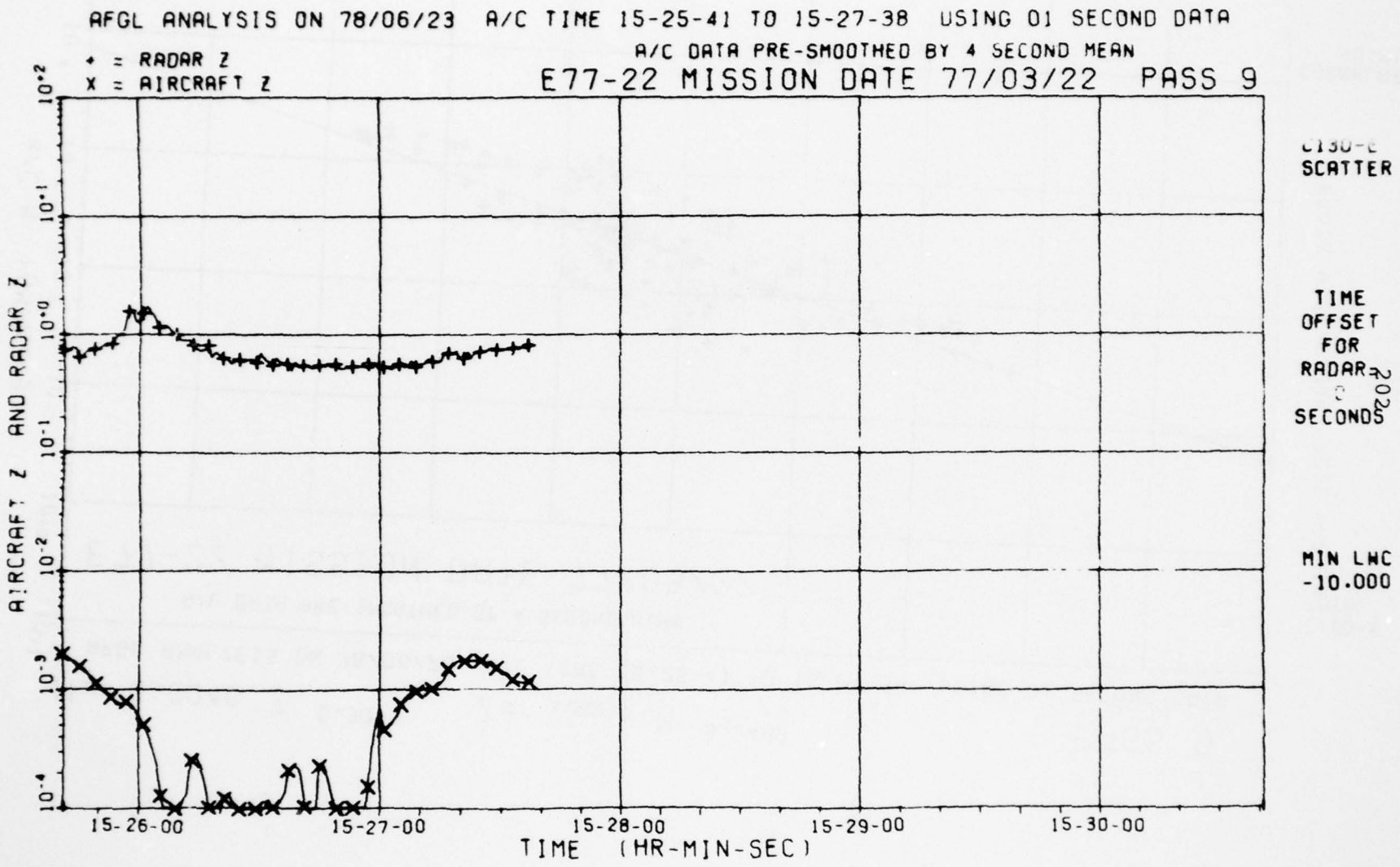


Figure 25D: RAPP Sample Plots

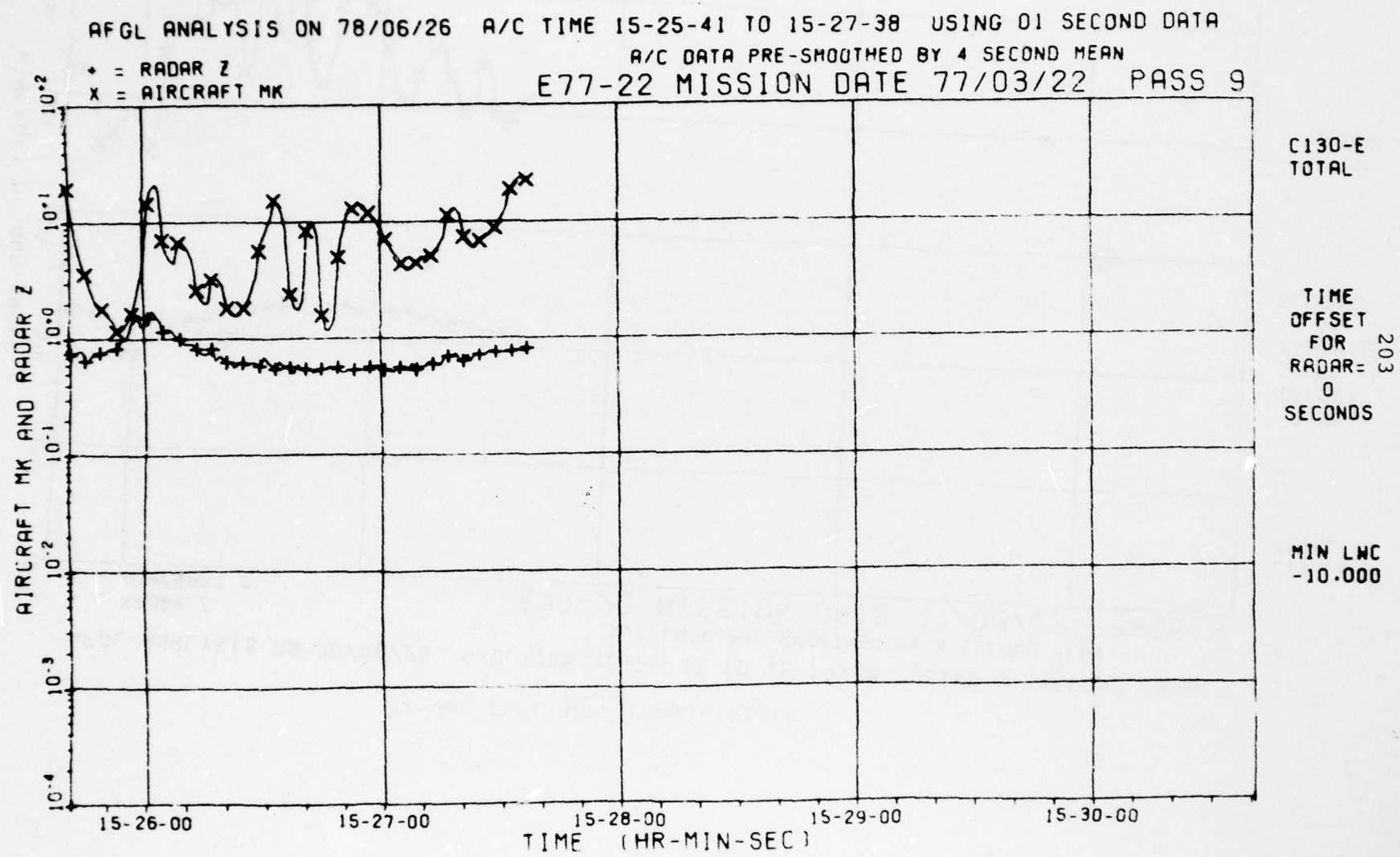
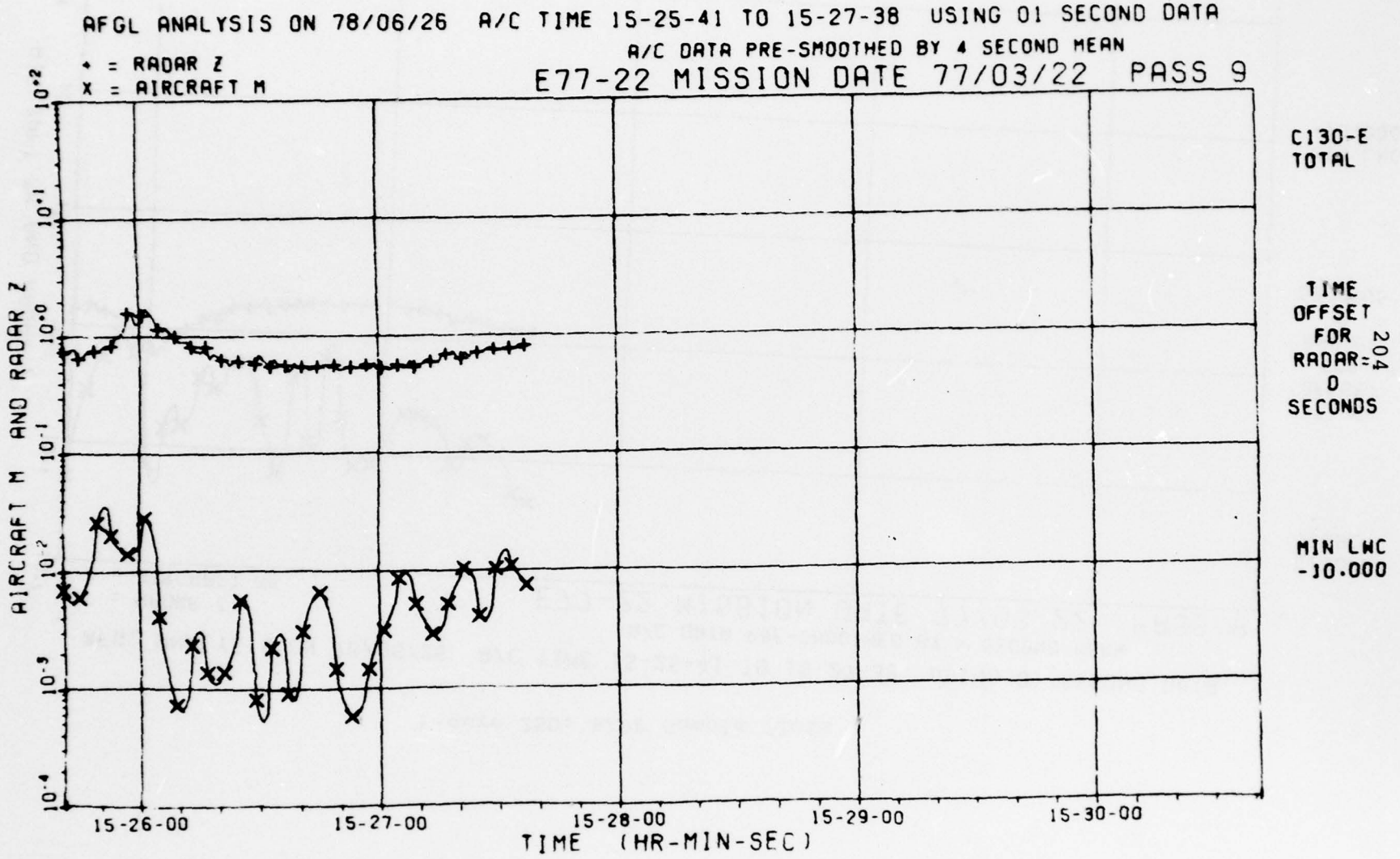


Figure 25E: RAPP Sample Plots



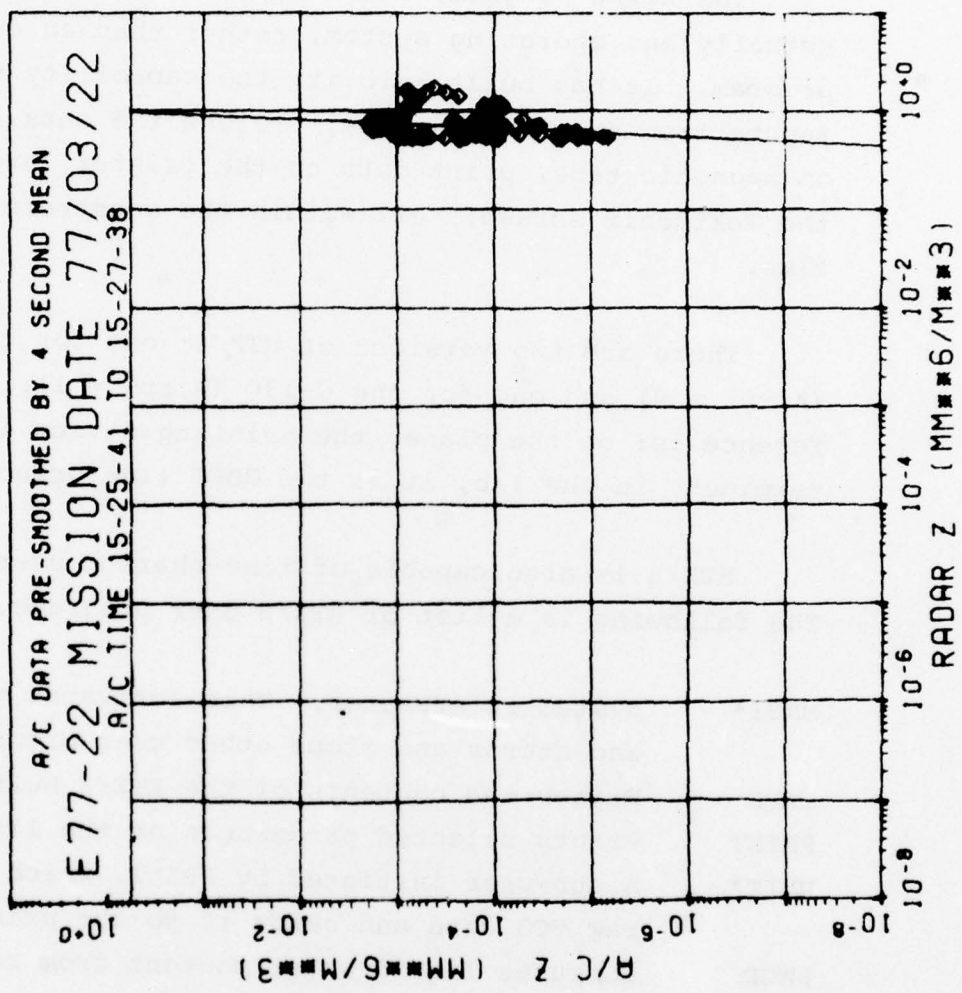


Figure 25F: RAPP Sample Plots

5.1 RTX/8

5.1.1 Program Description

The RTX/8 program, which runs on the DEC PDP-8/E, is actually an operating system, rather than an executing program. It has built into it: the capability to take inputs from external devices, process the data, record it on magnetic tape, print data on the printer, and plot on the Tektronix screen, all within the constraints of real time.

There are two versions of RTX/8; one for the lab (Airpl = 0) and one for the C-130 (Airpl = 1). The difference is: on the plane, the printing device is the GE terminet, in the lab, it is the ODEC line printer.

RTX/8 is also capable of time-sharing user programs. The following is a list of RTX/8 user programs.

MNSI*	System interpreter. This activates the keyboard, and starts and stops other user programs
TAPE	Writes the contents of the RTX/8 buffer onto magtape
PRINT	Prints selected parameters on the line printer
UNIT*	A sub-user initiated by PRINT, which calibrates the raw VCO data and sends it to the print buffer
LWCD	Computes liquid water content from raw probe counts
PLOT	Plots selected parameters on the Tektronix screen

* SPECIAL USER PROGRAMS (NOT EXECUTABLE VIA KEYBOARD)

5.1.2 Operating Instructions

1) mount system tape on dectape 0.
2) turn Tektronix screen and hard copy unit on
3) key 7470 into switch register
4) Press:
   a. ADDR LOAD
   b. EXT ADDR LOAD
   c. CLEAR
   d. CONTINUE
   Computer will respond with a dot on the screen
5) type: R RTX8 (must include a space between R and RTX8)
6) RTX8 will clear the screen, type current version number and ask for today's date in the form DDMMYY
7) put console knob on AC. This will display a rotation of lights on the computer.

Commands recognized by RTX8

CTRL/C: Causes '*' to be printed on the screen and get the attention of RTX8 so programs may be turned ON and OFF

CTRL/E: Clear and reset the screen (If PLOT is running, a new graph will be started. NO HARD COPY)

CTRL/P: Causes hard copy, clear and reset the screen. (If PLOT is running, a new graph will be started)

5.2 User Program LWCD

5.2.1 Program Description

LWCD computes the total liquid water content from the raw probe counts. Additionally, it performs several auxillary calculations. These include: radar reflectivity (Z), for factor (F), MK and stability factor (S). 'LWC', 'Z', 'F', 'MK' and 'S' are sent, in ASCII, to the output buffer used by program PRINT. They are also sent fixed point, single precision (with a scaling factor) to the PLOT program.

5.2.2 Operating Instructions

TYPE: ON,LWCD↓

VELOCITY:

HARDWARE INPUT OKAY?

If the true airspeed is to be used, type "Y". If keyboard is desired, type "N". If "N", the system responds with

VELOCITY:

Type the velocity in knots

PARTICLE:

HARDWARE INPUT OKAY?

If "N", RTX-8 types:

PARTICLE TYPE (1-5)?

Select the proper particle type:

1 = RAIN
2 = WET SNOW
3 = LARGE SNOW
4 = SMALL SNOW
5 = BULLET-ROSETTES

PROBE:C,P, or B?

Select cloud probe (C), precipitation probe (P) or both (B).

5.3 User program TAPE

5.3.1 Program Description

Program TAPE assumes the VCO input in the form shown in Appendix 24 and it assumes the PMS data is coming in at a rate of 256 characters (4 bits each) per second. The output on magnetic tape is in the form shown in Appendix 26.

TAPE can also read PDP-8 flight tapes in the Lab. To do this, 4 locations must be manually changed using the switches on the front panel of the computer.

LOCATION	FROM	TO
10644	7650	7200
10711	0001	0002
05032	1725	7200
05033	3725	7200

5.3.2 Operating Instructions

1) Put a tape on the TU-10
   (Make sure tape drive is on-line and tape has a write ring)

2) TYPE:

   ON,TAPE↓

   To terminate this program

   TYPE:

   OFF,TAPE↓

5.4 User program PLOT

5.4.1 Program Description

This user program plots the data (see figure 26) output by the LWCD program on the Tektronix CRT. This includes LWC, F, S, MK and Z. The operator can choose any one of these parameters to be plotted; if M is chosen, a choice of three ranges is available. The axes are drawn on the right half of the CRT, leaving the left side for operator dialog. Each plot is labelled with function, time, maximum value and date so it can easily be identified. Each tick mark on the abcissa represents one minute. On the ordinate a tick represents one-fifth of the maximum. After five minutes, the plot fills up and automatically a hard copy is made, the screen erased and new axes are drawn and labelled. A new plot and hard copy is also generated whenever the screen is erased by operator dialog filling the screen, or a control/P function. Control/E will only cuase a new plot on the screen without a copy.

If any data exceeds the plot maximum, an interpolation is done and a line drawn to where the line would have left the plot area. This also occurs when the data returns to the range of the plot.

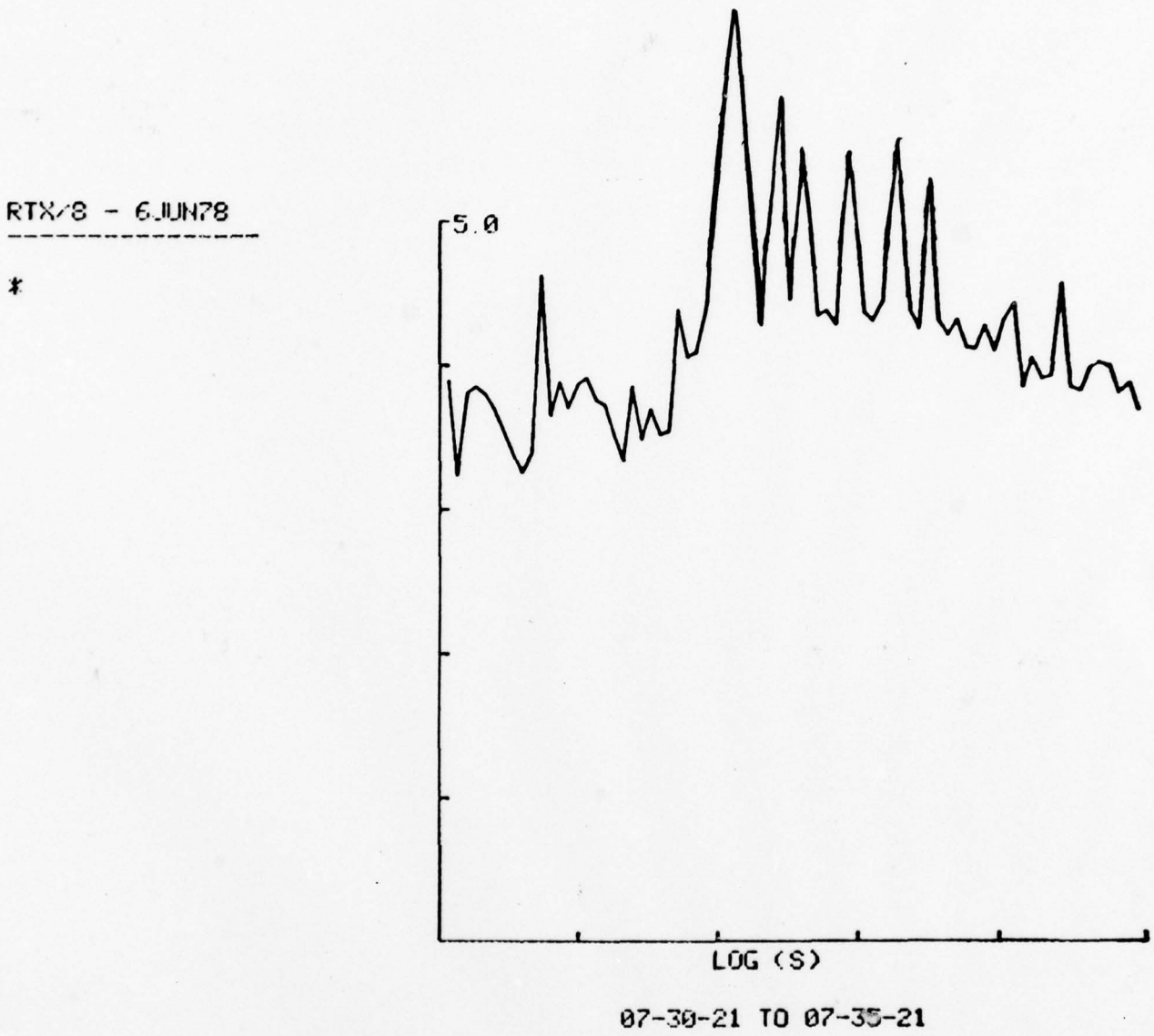


Figure 26: User Program PLOT Sample Plot

5.5 User Program PRINT

5.5.1 Program Description

This user program sends one line of information to the GE Terminet (or ODEC in Lab) printer each time the Knollenberg buffer fills (every four seconds). This contains calibrated VCO readings, a time code, LWCD results and a particle distribution. A brief description of each of the output parameters follows (see figure 27).

PT	Particle type (R=rain, W=wet snow, L=large snow, S=small snow, B=bullet rosettes
ET	Elapsed time as read from PMS-1D buffer
TIME	From Stancil Hoffman time code generator. Hours, minutes and seconds (HH:MM:SS) are included on line 1, seconds only appear on lines 2-15
ALT	Altitude in kilofeet: calculated as a fifth degree polynomial from the Kistler pressure reading
TEMP	Temperature in degrees centigrade
MAGH	Magnetic heading in degrees (0-136°N)
DEWPOINT	in degrees Centigrade
TAS	True airspeed as read from the TAS computer
JW-LWC	reading from the Johnston-Williams device
EWER	LWC reading as output from the NOVA computer
LWC	liquid water content results } from user program LWCD
Z	radar reflectivity } from user program LWCD
MK	$M/\sqrt{Z}$ ratio } from user program LWCD
F	form factor computation } from user program LWCD
S	stability factor } from user program LWCD

The particle distribution is displayed as one minute sums for the 15 PMS size channels. Note that the 45 sums that appear are sums of a one minute interval ending at the time associated with the data. That is in the output format shown in figure 27, the first set of sums are for particle during 07:33:01 to 07:34:00

5.5.2 Operating Instructions

1. Turn Terminet printer ON
   (The switch is on the back and at the right as you face it.)

2. Press the LOCAL button hit a carriage return and make sure there is a 1 in the print column light.

3. Position paper so it will begin printing at the very top of the page.

4. Press the ON LINE button, the READY light should be on if everything is all set.

5. To activate the PRINT program type

   ON,PRINT

NOTE: The PRINT program will only print LWC, Z, MK, F and S if the LWCD program is on. Otherwise only the VCO and probe counts data will be printed.

LH	SCATTER	CLOUD	PRECIP	PT	SEC	ET	ALT	TEMP	MAGH	DEWP	JD	TAS	EWSR	LWC	Z	MK	F	S
1	5953	16	6914	R	J7:32:21	101	4.6	6	135	3	0.2	200	5607	6.67276	.25+06	1354	0.047	*****
2	6707	65	3827	R	25	105	4.6	6	136	3	0.2	200	5568	12.45522	.12+06	3577	0.078	*****
3	2025	59	2025	R	29	109	4.7	5	133	2	0.1	200	5544	5.86896	.29+06	1083	0.047	*****
4	1432	29	826	R	33	113	4.8	5	132	2	0.2	200	5577	2.86.799	.14+06	7427	0.104	*****
5	1220	17	355	R	37	117	4.8	5	131	2	0.1	200	5570	3.01781	.24+06	765	0.123	19451
6	938	26	168	R	41	121	4.9	5	128	2	0.2	200	5555	7.62542	.30+06	1375	0.048	*****
7	874	22	79	R	45	125	5.0	5	126	2	0.3	200	5526	30.41955	.30+06	4920	0.069	*****
8	456	31	29	R	49	129	5.1	5	127	1	0.2	200	5513	2.52537	.13+06	692	0.096	29069
9	344	37	33	R	53	133	5.2	5	127	1	0.3	200	5523	0.57998	.25+06	1718	0.053	*****
10	215	38	18	R	57	137	5.2	5	127	1	0.2	200	5526	8.91790	.20+06	1674	0.052	*****
11	198	29	8	R	J7:33:01	141	5.3	5	129	1	0.2	200	5536	5.73843	.46+06	838	0.121	23232
12	125	15	6	R	05	145	5.4	5	128	1	0.2	200	5525	4.78.20	.09+06	761	0.111	23867
13	122	20	3	R	09	149	5.5	5	128	1	0.1	200	5498	4.23941	.32+06	743	0.122	15248
14	94	9	3	R	13	153	5.6	5	126	1	0.1	200	5487	9.91220	.40+06	1555	0.048	*****
15	168	3342	2	R	17	157	5.7	4	125	1	0.1	200	5472	9.91463	.34+06	1697	0.052	*****
1	19373	34	2314	R	21	161	5.8	4	124	0	0.1	200	5467	5.05125	.29+06	935	0.125	23115
2	135494	40	4609	R	25	165	5.9	4	123	0	0.2	200	5456	4.69235	.26+06	846	0.126	24002
3	205040	49	2436	R	29	169	5.9	4	125	0	0.2	200	5450	4.15867	.20+06	907	0.112	27005
4	125209	34	1005	R	33	173	6.0	4	127	0	0.1	200	5461	12.14271	.32+06	2145	0.051	*****
5	45050	76	670	R	37	177	6.1	4	130	-0	0.2	200	5459	6.08.52	.15+06	1702	0.073	*****
6	12049	103	446	R	41	181	6.1	4	130	-0	0.2	200	5443	6.00.177	.33+06	1059	0.130	23005
7	9051	129	305	R	45	185	6.2	4	129	-0	0.2	200	5426	3.66095	.18+06	869	0.137	18013
8	1280	115	232	R	49	189	6.3	4	128	-0	0.1	200	5423	6.42078	.23+06	1320	0.055	*****
9	683	133	197	R	53	193	6.4	4	127	-0	0.2	200	5427	4.80478	.24+06	1033	0.140	20417
10	366	101	131	R	57	197	6.4	4	125	-0	0.1	200	5429	3.43135	.15+06	861	0.143	16227
11	412	97	114	R	J7:34:01	201	6.5	4	124	-1	0.2	200	5419	3.77792	.13+06	1026	0.139	20553
12	337	47	67	R	05	205	6.6	4	124	-1	0.1	200	5406	3.83309	.91+05	1267	0.192	13574
13	313	48	57	R	09	209	6.6	4	127	-1	0.2	200	5402	3.17514	.55+05	1352	0.200	13043
14	318	36	59	R	13	213	6.7	4	131	-1	0.2	200	5401	3.98647	.16+06	969	0.141	19001
15	518	20171	38	R	17	217	6.8	3	133	-1	0.3	200	5394	2.36910	.42+05	1160	0.187	12638
1	4238	32	5434	R	21	221	6.9	3	139	-1	0.2	200	5380	2.93495	.55+05	1203	0.151	20509
2	39571	21	6521	R	25	225	7.0	3	144	-1	0.3	200	5349	6.29145	.75+04	733	0.103	26548
3	54965	34	8152	R	29	229	7.2	3	141	-1	0.2	200	5336	6.30102	.70+05	2373	0.358	7182
4	58077	47	3775	R	33	233	7.3	3	141	-1	0.3	200	5329	1.97.45	.26+05	1204	0.206	10788
5	47687	82	1449	R	37	237	7.4	3	140	-1	0.2	200	5326	1.01176	.47+04	1461	0.265	6365
6	35674	157	836	R	41	241	7.4	3	139	-1	0.2	200	5329	1.31.76	.89+04	1394	0.252	6479
7	25765	153	551	R	45	245	7.5	3	139	-2	0.3	200	5321	1.04794	.53+04	1427	0.122	37046
8	15358	147	329	R	49	249	7.6	3	139	-2	0.3	200	5303	0.80475	.25+04	1600	0.296	7071
9	9067	151	213	R	53	253	7.7	3	139	-2	0.3	200	5305	0.93363	.36+04	1545	0.298	6752
10	3802	109	126	R	57	257	7.7	3	139	-2	0.4	200	5298	1.68144	.51+04	1923	0.276	9749
11	1928	130	62	R	J7:35:01	261	7.8	2	138	-2	0.4	200	5284	1.32570	.53+04	1817	0.263	10159
12	762	51	55	R	05	265	7.9	2	138	-2	0.3	200	5261	1.65429	.73+04	1934	0.279	9636
13	499	49	36	R	09	269	8.0	2	138	-2	0.4	200	5242	0.96428	.32+04	1702	0.320	6430
14	347	2253	32	R	13	273	8.1	2	138	-3	0.5	200	5217	1.01260	.35+04	1711	0.297	7038
15	683	1151	15	R	17	277	8.2	2	138	-3	0.5	200	5191	0.68392	.14+04	1614	0.381	4845

Figure 27

6.1 QWIK4

6.1.1 Program Description

QWIK4 performs a quick look type dump of all 1D PMS and PDP8 data tapes from the C130E. The dump printed by the program includes time printouts, raw and calibrated VCO's, total probe counts, and certain values derived from this data.

The program may be run in two different modes. The first mode dumps the entire tape printing averages over a specified interval. The second mode allows flight time or elapsed time to be used to locate a record. This feature will be useful in locating the start of a sampling run or any time interval of interest.

NOTE: There are two versions of QWIK4, one for the plane, and one for the Lab.

6.1.2 Operating Instructions

Mount the magtape to be dumped on unit 0 with the write enable ring removed to prevent any possible correuption of data.

Turn on the GE Terminet printer (or ODEC if in the Lab), press 'ON LINE' button and be sure that the paper is free to feed.

Respond to the OS/8 dot (.) by typing "R QWIK4" (return).

When QWIK4 is started it will print

```
0 = TTY, 1 = ODEC.  THEN PRESS CONTINUE.
QUICK-LOOK PROGRAM
```

If QWIK4 is being run in the Lab, it will type:

"SET SWITCH #11.

This will direct output to DECwriter, or line printer

```
FLIGHT TAPE (F) OR KENNEDY TAPE (K)?
```

Respond by typing F if the magtape is a PDP8 generated flight tape or K if the tape is from Kennedy tape recorder in the PMS system. Terminate input with a return.

NOTE: <u>all</u> inputs to QWIK4 are terminated with a return.

```
FLIGHT NO., DATE?
```

Enter the flight number and date or a string of up to 30 characters which identifies the tape. The program then asks

DATE PROCESSED,COMMENTS?

Enter date, and any comments (30 characters)

ALL (A) OR SPECIFIED (S) TIMES?

Respond with A to dump the whole tape starting at whatever record the tape head is currently at. The program will not rewind the tape to the load point before dumping. This is useful if the program fails to locate a specified time interval. The operator may position the tape to approximately where the desired time would be using the off line controls on the TU10. The A option may then be used to determine what was recorded on the tape. There is one small problem associated with this procedure. When the off line controls are used to forward space or backspace the tape, the TU10 does not stop on an even record boundary. Therefore the first few seconds of data produced by the program should be ignored if the tape has been moved with the off-line controls. The program will detect this error condition and print

!!!INCORRECT MAGTAPE RECORD LENGTH!!!

This printout is normal after the tape has been moved with the off-line controls, however it should only print <u>once</u>. The first read done by the TU10 will reposition the tape head to the beginning of a record and subsequent records should be readable without generating this error. If this

printout repeats continuously the tape is not in the correct format and any results printed by the program will be incorrect.

The S option allows the operator to specify a time interval on the tape to be dumped. If this option is selected the program then prints

CLOCK (C) OR ELAPSED (E) TIME?

Type C to use the flight time clock to look up records or E to use the PMS buffer elapsed time. The program will attempt to find the specified time interval no matter where it is on the tape and will minimize tape motion as much as possible. If the tape has gone beyond the time interval desired the program will backspace as necessary to rewind the tape to the load point before each run.

After the operator has specified which clock to use the program will print

START TIME

Respond by typing the starting time for the dump in the form SSSS to specify a four digit elapsed time in seconds or HH:MM:SS to specify a flight time. The program will then print

STOP TIME

Respond with the time to stop the dump at in the same form used for the starting time

The program now asks

AVERAGING INTERVAL (SECS)

This question is printed for both the specified time interval and dump all times mode. Respond with the number of seconds to be represented in each printout.

The program then begins calculating averages over the specified time interval and printing a report for each interval. Contained in each printout are the start and stop flight and elapsed times for the interval, average VCO values, average values of parameters derived from the VCO's, and total probe counts.

Some sample printout is contained in figure 28.

The program may be restarted from the beginning by setting the switches to 0200 and pressing HALT, ADDR LOAD, EXT ADDR LOAD, CLEAR, CONTINUE.

Alternatively the program can be restarted from the "ALL (A) OR SPECIFIED (S) TIMES?" question by setting the switches to 0000 and pressing HALT, ADDR LOAD, EXT ADDR LOAD, CLEAR, CONTINUE.

The following error messages may print out during execution of QWIK4.

printout	possible cause(s)	recommended action(s)
TIME INTERVAL OUT OF RANGE	time specified not on tape	use "A" option to see what is on tape
END OF TAPE	time specified not on tape	rewind tape and try another time interval
!!!MAGTAPE PARITY ERROR!!!	bad tape, bad TU10	try another tape;if the printout is infrequent it may be ignored;however if data looks bad this is the cause
!!!INCORRECT MAGTAPE RECORD LENGTH!!!	bad tape (unlikely) question asking if tape was Kennedy tape (PMS) or Flight tape (PDP8) was answered incorrectly tape head was not on even record boundary due to operator moving it using off-line controls	try another tape;restart program at 0200 and answer question correctly no action necessary simply ignore results of first averaging interval

Some errors will not be detected by the program. Following is a list of the conditions and recommended actions.

disposition	possible causes(s)	recommended action(s)
TU10 "rocks" and will not locate time specifies	bad times on tape	use "A" option to dump tape
program will not load	bad system tape unknown	try backup system tape notify DPSI
program "hangs up"	unknown	record AC, PC, MQ and notify DPSI
program halts	unknown	record AC, PC, MQ and notify DPSI

```
QUICK-LOOK PROGRAM
SET SWITCH #11.  0=TTY, 1=DUEC.  THEN PRESS CONTINUE.
FLIGHT TAPE (F) OR KENNEDY TAPE (K)? F
FLIGHT NO., DATE? E17722, 20 MAR 77
DATE PROCESSED, COMMENTS?6 JUN 78, SAMPLE
ALL (A) OR SPECIFIED (S) TIME? A
AVERAGING INTERVAL (SECS)  60


**********************************************************************
                          *                    *
                          *  QUICK-LOOK DUMP   *
                          *   C130E  PDP8      *
                          *                    *
                          **********************

FLIGHT INFORMATION                    60  SECOND AVERAGE
                                        AIRCRAFT TIME          ELAPSED TIME
E17722, 20 MAR 77                     START          STOP      START   STOP
6 JUN 78, SAMPLE                      07:30:33    07:31:32       993    1052

VCO              RAW      CONVERTED                      TOTAL  PROBE  COUNTS

I.A.S.          7035    179.701 (KNOTS)          CHANNEL     SC     CL     FR
TEMPERATURE     5849      8.157 (DEG C)
PRESSURE        8638   1046.891 (MB)                 1     906     18   2209
DEWPOINT        5229      3.056 (DEG C)              2    1146     49   2664
LWC/JW          5004      0.050 (G/M**3)             3    1239     65   2430
MAG HEADING     2408     92.851 (DEG)                4    1106     17   1797
K-PRESS         2277    907.998 (MB)                 5     994      6    448
T.A.S.          5092    204.620 (KNOTS)              6     683      8    147
                                                     7     694      4     58
                                                     8     335     17     26
HEIGHT          2998.03 (FEET)                       9     291     21     13
DELTA  PRESS      54.02 (MB)                        10     161     21      6
IAS  (CALC.)     186.91 (KNOTS)                     11     145     17      1
TRUE TEMP          3.57 (DEG C)                     12      93      9      4
                                                    13      90     13      1
                                                    14      65      9      1
                                                    15     105   1124      2
```

Figure 28: QWIK4 Sample Output

6.2 KNMON

6.2.1 Program Description

Program KNMON was written for testing and verification of the PMS-1D interface. It also allows the associated M1703 card to be checked out. Any desired channel selected by the operator may be monitored. Every second the PMS-1D system send 64 four character words to the computer. Actually the PDP-8E receives its data one character at a time in 1/256 second intervals. However it takes one second for the 64 words to become available. Each second the value of the selected channel is printed. Refer to Appendix 3 for the table of PMS channels.

NOTE: KNMON can only function correctly when run on the plane

6.2.2 Operating Instructions

1. Respond to the OS/8 dot by typing "R KNMON" (return)

2. After KNMON is started it will print

   KN CHANNEL

   Respond by typing the Knollenberg channel to monitor (from 1 to 64) followed by a return.

3. To select another channel set SR to 0200 and press 'HALT', ADDR LOAD, 'EXTD ADDR LOAD', 'CLEAR', 'CONTINUE' then continue from step 2.

6.3 PLOT

6.3.1 Program Description

Program PLOT was written for calibration and general plotting at LYC. A modified version has also been generated for use on the airplane with input on the GE keyboard and output on the CRT and GE printer.

Program PLOT will

(a) plot an x-y table on the Tektronix plotter; the table is inputted at the DECwriter (or GE keyboard if on plane). If desired, the x and/or y values can be modified by logging them in order to produce a linear-linear, a linear-log, a log-linear or a log-log plot.

(b) generate the x values automatically after a specification of the first x and x-step is given

(c) allow the user to select the low and high values of x and y to be used on the plot

(d) plot each point +; the user can choose whether or not to connect the plotted points with a line

(e) label the plot with an alphabetic description

(f) plot a least square best fit curve to the data (first or second degree), and print out the fitting function

(g) generate a table of deviations of the least square fit to the original data, and calculate the RMS error

(h) allow the user to modify the data, limits and descriptions and replot, with a new least square fit, without having to retype the entire x-y table.

An example of the plot created by the program will be found in figures 29 & 30.

6.3.2 Operating Instructions

In order to execute program PLOT, and perform the many optional capabilities, the following step-by-step procedure should be executed:

1. Mount DECtape containing 'PLOT' on unit 0, write enabled and remote

2. Switches set to 7470

3. Press ADDR-LOAD, EXT-ADDR-LOAD, CLEAR, CONT

4. Computer responds with a dot

5. Type R PLOT

6. Within 22 seconds the computer responds with

   PLOTTING PROGRAM

7. IS X ON LOG SCALE?
   If the x-data is to be logged base 10, answer Y otherwise N

8. IS Y ON LOG SCALE?
   If the y-data is to be logged base 10, answer Y otherwise N

9. IS DELTA X CONSTANT?
   If the x-data (before taking logs) is equally spaced, answer Y, otherwise N

10. If delta x is constant, the computer will request X-START

and DELTA-X, as X-START?
Type the starting value and return,

DELTA-X?

Type the difference between successive x-values and return

11. The computer responds with

ENTER X,Y TABLE

or ENTER Y TABLE (for constant delta-x)

12. For each value input the computer will first print the index number (1,2,3,...etc.). If only y-values are being inputted, the user will type the y-value followed by a return; if both x and y values are being inputted, the user will type the x-value, followed by a comma, followed by the y-value and a return.

13. When all values have been inputted, type

1E35 return

14. The computer will respond with

LIMITS OF X ARE xxxxx, xxxxx

which indicates the low and high values of the x-table. Then it prints

TYPE LIMITS TO USE

The computer expects two numbers, separated by a comma, the first number is the value of x at the left end of the plot; the second is the value of x at the right end

of the plot. There will automatically be 10 divisions in this range. If the first limit typed is unacceptable (larger than the limit found) or if the second limit typed (smaller than the limit found) is unacceptable, step 14 is repeated.

15. Step 14 is done for Y

16. The computer will print

    CONNECTING LINE?

    If a line is desired between points in the order they were typed in, answer Y. An answer of N will eliminate the connecting line.

17. The computer will responde

    TURN ON PLOTTER, TYPE DESCRIPTION

    Type a description to be printed on the bottom of the plot. This description is limited to 67 characters. A rubout will respond with a carriage return, and the user should type the entire description over again. Make sure plotter is on, and "on-line" before pressing return.

18. The plot will be made. At its conclusion, the computer will ask

    LEAST SQUARE FIT?

    If a curve fitting the data is desired answer Y; otherwise answer N and proceed to step 22.

19. The computer responds

    DEGREE (1 OR 2)?

    Degree 1 is a straight line fit; degree 2 is a quadratic fit. Respond either 1 or 2. Any other response will force step 19 again.

20. The fitting curve will be plotted. The least square polynomial will be printed

    (a) at the top of the plot, and
    (b) on the DECwriter (or GE printer)

21. The computer then asks

    DEVIATIONS?

    If the table of x,y, calculated-y, deviation-y and RMS is desired, answer Y; otherwise answer N

22. The computer will ask

    REPLOT?

    If the data is to be modified, eliminated, or extended, or if another plot is to be made changing either x or y limits, or the description, or the fitting function, respond with Y; otherwise respond N and proceed at step 6

23. The computer will ask

    NUMBER?

    If there are no changes go to step 23(c).

    (a) The computer expects the index number of the data point being changed. It will accept an index number

one greater than the length of the table (omit the number corresponding to 1E35) with the assumption that the table is being extended. The table may be extended repeatedly by entering an index number equal to one more than the previous maximum number. If the number typed is invalid, step 23 is repeated. After the number is accepted, the computer will type

X,Y =

Respond with the value of x, a comma , the value of y return. Step 23 will be repeated. The data being typed will be logged according to responses made in steps 7,8

CAUTION: DO NOT ENTER 1E35 FOR THE LAST NUMBER.

The program knows how many points there are in the table.

(b) If a value of x,y is to be eliminated, after its index number has been accepted, and X,Y = has printed, type

1E35,1E35 return

(c) When all changes have been made, answer

NUMBER?

with 0 return
The procedure restarts at step 14

ERRORS

1. Alphabetic errors: If an error is discovered before return is pressed, and the information was alphabetic, as in steps 7,8,9,16,17,18,19,21,22 type the rubout key; the computer will respond with a carriage return; retype the entire response, beginning with the first character.

2. Numeric errors: If an error is discovered before a comma or return is pressed, and the information was a number, as in steps 10,12,14 and 23, type the rubout key; the computer will not respond (automatic feature of the 27 bit floating point package); then type the entire number over again, beginning with the first character.

   CAUTION: If two numbers were being inputted, separated by a comma, the rubout will erase the CURRENT NUMBER ONLY.

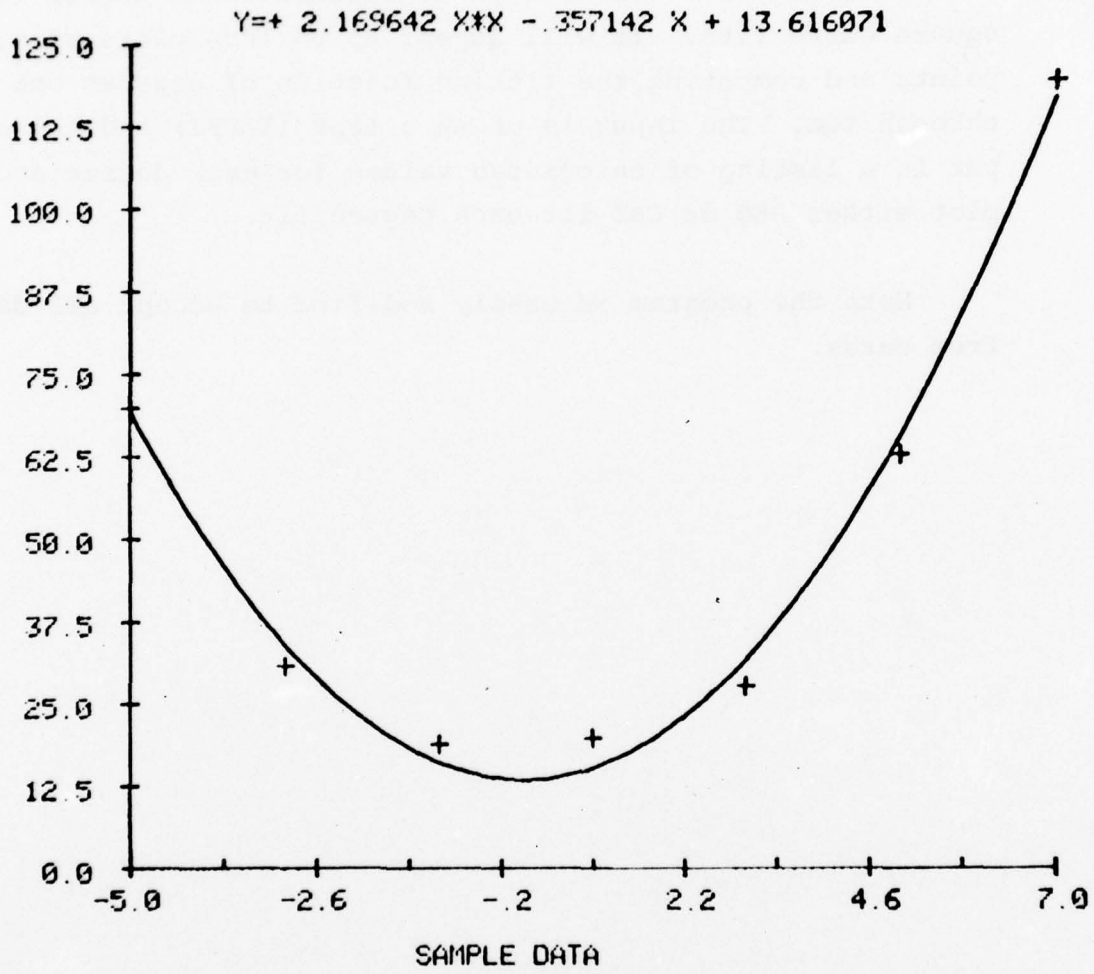
3. Incorrect responses to Y or N; The computer will specifically look for the Y. Any character other than Y will be treated as N except a carriage return, which should be used only after a character has been typed.

RESTART ADDRESS: 0200

```
PLOTTING PROGRAM

IS X ON LOG SCALE?N
IS Y ON LOG SCALE?N
IS DELTA X CONSTANT?Y
X-START?-5
DELTA-X?2
ENTER Y TABLE
   +1    -5.70
   +2    -3.31
   +3    -1.19
   +4    +1.20
   +5    +3.28
   +6    +5.63
   +7    +7.120
   +8    +9.1E35

LIMITS OF X ARE  -5, +7

TYPE LIMITS TO USE -5,7

LIMITS OF Y ARE  +19, +120

TYPE LIMITS TO USE 0,125

CONNECTING LINE?N

TURN ON PLOTTER, TYPE DESCRIPTION
SAMPLE DATA

LEAST SQUARE FIT?Y
DEGREE(1 OR 2)?2
Y = +2.169643 X**2  -0.357143 X  +13.616070
DEVIATIONS?Y

   X                Y                F(X)              DEV

  -5               +70              +69.642860        -0.357142
  -3               +31              +34.214290        +3.214286
  -1               +19              +16.142860        -2.857142
  +1               +20              +15.428570        -4.571428
  +3               +28              +32.071430        +4.071429
  +5               +63              +66.071430        +3.071430
  +7               +120             +117.42860        -2.571427
RMS= +3.210315
REPLOT?
```

Figure 29: PLOT Sample Session

Figure 30: PLOT Sample Plot



7.1 LSFIT

7.1.1 Program Description

Program LSFIT was written to calculate nth degree least square curve fits. It will accept up to 1000 pairs of x,y points and computing the fitting function of degrees one through ten. The input is on an a tape (TAPE1) and the output is a listing of calculated values for each degree and a plot either PEN or CRT for each degree fit.

Note the program is easily modified to accept all data from cards.

7.1.2 Control Cards

```
JOBNM,CM65000,T100.                          ID NO.        NAME
ATTACH,LGO,LSFITBIN,ID=GLASS.
ATTACH,TAPE1,DATA,ID=GLASS.
REQUEST,TAPE39,*Q.
DISPOSE,TAPE39,*FL.
ATTACH,CRT,OFFLINECRT.
LIBRARY,CRT.
LDSET,PRESET=ZERO.
LGO.
```

7.1.3 Input Requirements

RECORD 1

cc 1-30 execution time format statement defining how the x,y pairs are to be read.
ex. (F10.0,10X,F12.3) implies the x variable will be found in cc 1-10 and the y will be found in cc 21-32

RECORD 2

cc 1-30 data description that will be printed and plotted

RECORD 3 OPTION VARIABLES

cc 1-15 minimum x value (lower axis limit)
cc 16-30 maximum x value (highest axis limit)
cc 31-45 minimum y value (lower axis limit)
cc 46-60 maximum y value (highest axis limit)
cc 61-63 plot type PEN for pen plot
CRT for CRT plot
cc 66-70 not used
cc 71-75 = 1 if calibration data
= 0 if otherwise

RECORD 4-N

DATA in the format specified on record 1

7.1.4 Output Description

The first page of output (figure 31A) lists the input x and y values in columns one and two. The remaining ten columns list the calculated least square values for each x value.

The second page (figure 31B) lists the coefficients and RMS for each fitting function. The first number given is the constant term, followed by the slope and then the quadratic coefficient, etc.

The sheet (figure 31C) is a table of 50 values equally spaced over the x axis limits and the corresponding results of applying each degree of fit.

A sample plot is shown in figure 32.

X VALUE	Y VALUE	DEGREE 1	DEGREE 2	DEGREE 3	DEGREE 4	DEGREE 5	DEGREE 6	DEGREE 7	DEGREE 8	DEGREE 9	DEGREE 10
.8910E-02	.8810E-01	.8914E-01	.8767E-01	.8810E-01	.8810E-01	.8810E-01	.8810E-01	.8810E-01	.8810E-01	.8810E-01	.8810E-01
.1261E-01	.1246	.1264	.1243	.1246	.1246	.1246	.1246	.1246	.1246	.1246	.1246
.1545E-01	.1526	.1547	.1523	.1526	.1526	.1526	.1526	.1526	.1526	.1526	.1526
.1784E-01	.1762	.1787	.1760	.1762	.1762	.1762	.1762	.1762	.1762	.1762	.1762
.1994E-01	.1970	.1994	.1966	.1970	.1970	.1970	.1970	.1970	.1970	.1970	.1970
.2184E-01	.2158	.2187	.2157	.2158	.2158	.2158	.2158	.2158	.2158	.2158	.2158
.2360E-01	.2331	.2362	.2330	.2331	.2331	.2331	.2331	.2331	.2331	.2331	.2331
.2522E-01	.2491	.2519	.2491	.2491	.2491	.2491	.2491	.2491	.2491	.2491	.2491
.2675E-01	.2642	.2667	.2642	.2642	.2642	.2642	.2642	.2642	.2642	.2642	.2642
.2820E-01	.2785	.2795	.2785	.2785	.2785	.2785	.2785	.2785	.2785	.2785	.2785
.2959E-01	.2921	.2911	.2921	.2921	.2921	.2921	.2921	.2921	.2921	.2921	.2921
.3093E-01	.3051	.3053	.3051	.3051	.3051	.3051	.3051	.3051	.3051	.3051	.3051
.3219E-01	.3176	.3138	.3176	.3176	.3176	.3176	.3176	.3176	.3176	.3176	.3176
.3337E-01	.3295	.3302	.3295	.3295	.3295	.3295	.3295	.3295	.3295	.3295	.3295
.3454E-01	.3411	.3417	.3412	.3411	.3411	.3411	.3411	.3411	.3411	.3411	.341
.3567E-01	.3523	.3528	.3523	.3523	.3523	.3523	.3523	.3523	.3523	.3523	.3523
.3677E-01	.3631	.3636	.3632	.3631	.3631	.3631	.3631	.3631	.3631	.3631	.3631
.3784E-01	.3736	.3741	.3737	.3736	.3736	.3736	.3736	.3736	.3736	.3736	.3736
.3887E-01	.3838	.3842	.3839	.3838	.3838	.3838	.3838	.3838	.3838	.3838	.3838
.3988E-01	.3938	.3942	.3939	.3938	.3938	.3938	.3938	.3938	.3938	.3938	.3938
.4087E-01	.4035	.4039	.4036	.4035	.4035	.4035	.4035	.4035	.4035	.4035	.4035
.4183E-01	.4130	.4134	.4131	.4130	.4130	.4130	.4130	.4130	.4130	.4130	.4130
.4277E-01	.4223	.4225	.4224	.4223	.4223	.4223	.4223	.4223	.4223	.4223	.4223
.4369E-01	.4313	.4315	.4315	.4313	.4313	.4313	.4313	.4313	.4313	.4313	.4313
.4459E-01	.4402	.4404	.4403	.4402	.4402	.4402	.4402	.4402	.4402	.4402	.4402
.4547E-01	.4489	.4491	.4491	.4489	.4489	.4489	.4489	.4489	.4489	.4489	.4489
.4634E-01	.4575	.4575	.4576	.4575	.4575	.4575	.4575	.4575	.4575	.4575	.4575
.4719E-01	.4659	.4659	.4660	.4659	.4659	.4659	.4659	.4659	.4659	.4659	.4659
.4803E-01	.4741	.4741	.4742	.4741	.4741	.4741	.4741	.4741	.4741	.4741	.4741
.4885E-01	.4822	.4822	.4823	.4822	.4822	.4822	.4822	.4822	.4822	.4822	.4822
.4966E-01	.4901	.4901	.4903	.4901	.4901	.4901	.4901	.4901	.4901	.4901	.4901
.5045E-01	.4980	.4979	.4981	.4980	.4980	.4980	.4980	.4980	.4980	.4980	.4980
.5123E-01	.5057	.5056	.5058	.5057	.5057	.5057	.5057	.5057	.5057	.5057	.5057
.5200E-01	.5133	.5131	.5134	.5133	.5133	.5133	.5133	.5133	.5133	.5133	.5133
.5276E-01	.5208	.5206	.5209	.5208	.5208	.5208	.5208	.5208	.5208	.5208	.5208
.5351E-01	.5281	.5279	.5282	.5281	.5281	.5281	.5281	.5281	.5281	.5281	.5281
.5425E-01	.5354	.5352	.5355	.5354	.5354	.5354	.5354	.5354	.5354	.5354	.5354
.5498E-01	.5426	.5423	.5427	.5426	.5426	.5426	.5426	.5426	.5426	.5426	.5426
.5569E-01	.5497	.5494	.5498	.5497	.5497	.5497	.5497	.5497	.5497	.5497	.5497
.5640E-01	.5566	.5564	.5567	.5566	.5566	.5566	.5566	.5566	.5566	.5566	.5566
.5710E-01	.5635	.5632	.5636	.5635	.5635	.5635	.5635	.5635	.5635	.5635	.5635
.5780E-01	.5704	.5701	.5705	.5704	.5704	.5704	.5704	.5704	.5704	.5704	.5704
.5848E-01	.5771	.5769	.5772	.5771	.5771	.5771	.5771	.5771	.5771	.5771	.5771
.5916E-01	.5838	.5834	.5838	.5838	.5838	.5838	.5838	.5838	.5838	.5838	.5838
.5982E-01	.5903	.5901	.5904	.5903	.5903	.5903	.5903	.5903	.5903	.5903	.5903
.6049E-01	.5968	.5965	.5969	.5968	.5968	.5968	.5968	.5968	.5968	.5968	.5968
.6114E-01	.6033	.6029	.6034	.6033	.6033	.6033	.6033	.6033	.6033	.6033	.6033
.6179E-01	.6096	.6092	.6097	.6096	.6096	.6096	.6096	.6096	.6096	.6096	.6096
.6243E-01	.6160	.6155	.6160	.6160	.6160	.6160	.6160	.6160	.6160	.6160	.6160
.6306E-01	.6222	.6217	.6223	.6222	.6222	.6222	.6222	.6222	.6222	.6222	.6222
.6369E-01	.6284	.6277	.6284	.6284	.6284	.6284	.6284	.6284	.6284	.6284	.6284
.6431E-01	.6345	.6341	.6345	.6345	.6345	.6345	.6345	.6345	.6345	.6345	.6345
.6492E-01	.6405	.6401	.6406	.6405	.6405	.6405	.6405	.6405	.6405	.6405	.6405
.6553E-01	.6465	.6460	.6466	.6465	.6465	.6465	.6465	.6465	.6465	.6465	.6465
.6614E-01	.6525	.6521	.6525	.6525	.6525	.6525	.6525	.6525	.6525	.6525	.6525
.6674E-01	.6584	.6578	.6584	.6584	.6584	.6584	.6584	.6584	.6584	.6584	.6584

Figure 31A: LSFIT Sample Output

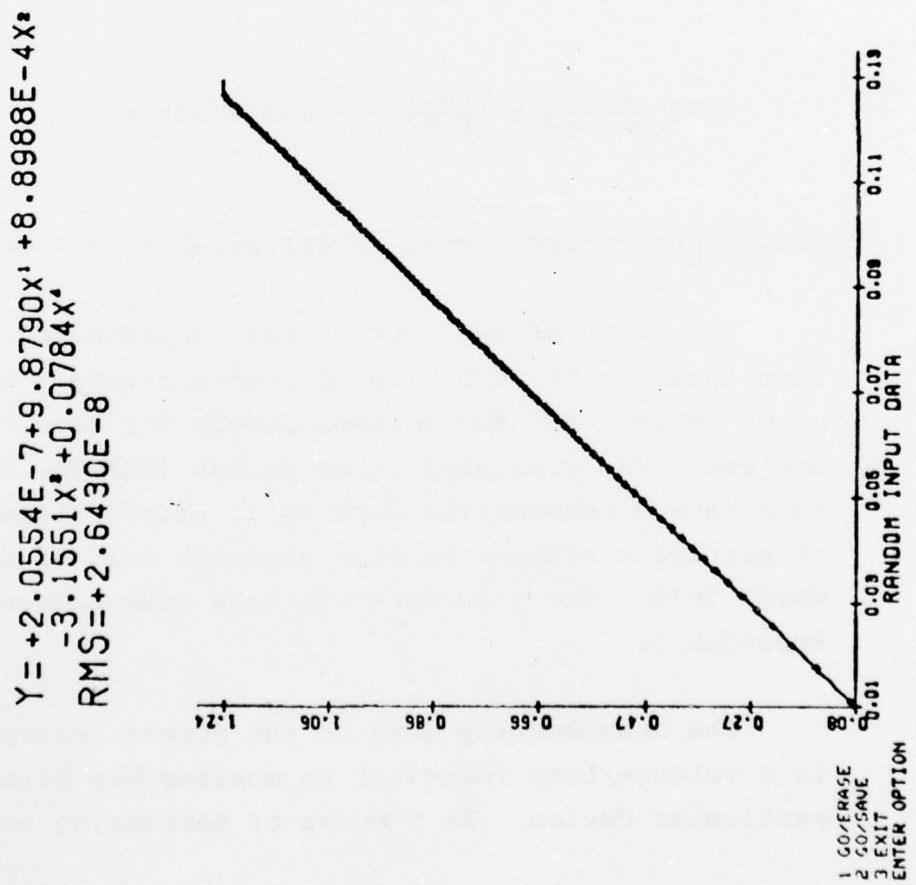
```
S. FIT OF DEGREE  1 HAS RMS= .621375E-03   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
25795E-02  9.8134

S. FIT OF DEGREE  2 HAS RMS= .352195E-04   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
77168E-03  9.9232      -.33713

S. FIT OF DEGREE  3 HAS RMS= .635768E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
72128E-06  9.8791      -.12307E-02 -3.1326

S. FIT OF DEGREE  4 HAS RMS= .264308E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
23554E-06  9.8790      -.33933E-03 -3.1551      .78431E-01

S. FIT OF DEGREE  5 HAS RMS= .246368E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
92273E-06  9.8790      -.13437E-03 -3.1376      -.56127E-01  .38267

S. FIT OF DEGREE  6 HAS RMS= .246928E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
25516E-07  9.8790      -.26371E-03 -3.1343      -.47592E-01  .63676      -.60779

S. FIT OF DEGREE  7 HAS RMS= .246308E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
21619E-07  9.8790      .37459E-03 -3.1542       .25566      -2.8261      17.008      -36.295

S. FIT OF DEGREE  8 HAS RMS= .246795E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
92142E-06  9.8790      -.19712E-03 -3.1447      .33683E-01  .24023      -7.6990      71.060      -194.27

S. FIT OF DEGREE  9 HAS RMS= .246796E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
13370E-07  9.8790      -.44459E-03 -3.1160      -.78360      15.127      -175.42      1216.3      -4536.5      7001.6

S. FIT OF DEGREE 10 HAS RMS= .246786E-07   COEFFICIENTS ARE (CONSTANT TERM,FIRST ORDER,...)
78123E-07  9.8790      -.25230E-02 -2.9927      -5.2191      115.33      -1646.3      15183.      -87272.      .28486E+06 -.40385E+06
```

Figure 31B: LSFIT Sample Output

X VALUE	1 DEGREE	2 DEGREE	3 DEGREE	4 DEGREE	5 DEGREE	6 DEGREE	7 DEGREE	8 DEGREE	9 DEGREE	10 DEGREE
.800000E-02	.81127E-01	.79570E-01	.79030E-01	.79030E-01	.79030E-01	.79070E-01	.79030E-01	.79030E-01	.79030E-01	.79030E-01
.923231E-02	.93226E-01	.90784E-01	.91203E-01	.91204E-01	.91204E-01	.91204E-01	.91204E-01	.91204E-01	.91204E-01	.91204E-01
.104656E-01	.10537	.10300	.10336	.10338	.10338	.10338	.10338	.10338	.10338	.10338
.116978E-01	.11743	.11521	.11555	.11555	.11555	.11555	.11555	.11555	.11555	.11555
.129298E-01	.12952	.12741	.12772	.12772	.12772	.12772	.12772	.12772	.12772	.12772
.141621E-01	.14162	.13962	.13969	.13969	.13969	.13969	.13969	.13969	.13969	.13969
.153944E-01	.15372	.15182	.15207	.15207	.15207	.15207	.15207	.15207	.15207	.15207
.166266E-01	.16582	.16402	.16424	.16424	.16424	.16424	.16424	.16424	.16424	.16424
.178589E-01	.17792	.17622	.17641	.17641	.17641	.17641	.17641	.17641	.17641	.17641
.190911E-01	.19003	.18842	.18858	.18858	.18858	.18858	.18858	.18858	.18858	.18858
.203233E-01	.20212	.20062	.20075	.20075	.20075	.20075	.20075	.20075	.20075	.20075
.215556E-01	.21422	.21281	.21292	.21292	.21292	.21292	.21292	.21292	.21292	.21292
.227878E-01	.22632	.22501	.22508	.22508	.22508	.22508	.22508	.22508	.22508	.22508
.240200E-01	.23842	.23721	.23725	.23725	.23725	.23725	.23725	.23725	.23725	.23725
.252523E-01	.25053	.24941	.24942	.24942	.24942	.24942	.24942	.24942	.24942	.2494
.264845E-01	.26262	.26156	.26159	.26159	.26159	.26159	.26159	.26159	.26159	.26159
.277167E-01	.27472	.27374	.27375	.27375	.27375	.27375	.27375	.27375	.27375	.27375
.289490E-01	.28682	.28592	.28592	.28592	.28592	.28592	.28592	.28592	.28592	.28592
.301812E-01	.29892	.29810	.29808	.29808	.29808	.29808	.29808	.29808	.29808	.29808
.314134E-01	.31102	.31026	.31024	.31024	.31024	.31024	.31024	.31024	.31024	.31024
.326457E-01	.32312	.32245	.32241	.32241	.32241	.32241	.32241	.32241	.32241	.32241
.338779E-01	.33521	.33462	.33457	.33457	.33457	.33457	.33457	.33457	.33457	.33457
.351101E-01	.34731	.34680	.34673	.34673	.34673	.34673	.34673	.34673	.34673	.34673
.363423E-01	.35941	.35896	.35889	.35889	.35889	.35889	.35889	.35889	.35889	.35889
.375746E-01	.37151	.37113	.37104	.37104	.37104	.37104	.37104	.37104	.37104	.37104
.388068E-01	.38361	.38329	.38320	.38320	.38320	.38320	.38320	.38320	.38320	.38320
.400390E-01	.39571	.39545	.39536	.39536	.39536	.39536	.39536	.39536	.39536	.39536
.412712E-01	.40781	.40761	.40751	.40751	.40751	.40751	.40751	.40751	.40751	.40751
.425035E-01	.41991	.41977	.41967	.41967	.41967	.41967	.41967	.41967	.41967	.41967
.437357E-01	.43201	.43193	.43182	.43182	.43182	.43182	.43182	.43182	.43182	.43182
.449679E-01	.44411	.44409	.44397	.44397	.44397	.44397	.44397	.44397	.44397	.44397
.462002E-01	.45621	.45623	.45612	.45612	.45612	.45612	.45612	.45612	.45612	.45612
.474324E-01	.46831	.46838	.46827	.46827	.46827	.46827	.46827	.46827	.46827	.46827
.486647E-01	.48041	.48053	.48042	.48042	.48042	.48042	.48042	.48042	.48042	.48042
.498969E-01	.49251	.49267	.49256	.49256	.49256	.49256	.49256	.49256	.49256	.49256
.511291E-01	.50461	.50482	.50471	.50471	.50471	.50471	.50471	.50471	.50471	.50471
.523614E-01	.51671	.51696	.51685	.51685	.51685	.51685	.51685	.51685	.51685	.51685
.535936E-01	.52881	.52910	.52899	.52899	.52899	.52899	.52899	.52899	.52899	.52899
.548258E-01	.54091	.54127	.54113	.54113	.54113	.54113	.54113	.54113	.54113	.54113
.560581E-01	.55300	.55337	.55327	.55327	.55327	.55327	.55327	.55327	.55327	.55327
.572903E-01	.56510	.56550	.56541	.56541	.56541	.56541	.56541	.56541	.56541	.56541
.585225E-01	.57720	.57763	.57754	.57754	.57754	.57754	.57754	.57754	.57754	.57754
.597548E-01	.58930	.58976	.58967	.58967	.58967	.58967	.58967	.58967	.58967	.58967
.609870E-01	.60140	.60189	.60181	.60181	.60181	.60181	.60181	.60181	.60181	.60181
.622192E-01	.61350	.61401	.61394	.61394	.61394	.61394	.61394	.61394	.61394	.61394
.634515E-01	.62560	.62613	.62606	.62606	.62606	.62606	.62606	.62606	.62606	.62606
.646837E-01	.63770	.63825	.63819	.63819	.63819	.63819	.63819	.63819	.63819	.63819
.659159E-01	.64980	.65037	.65032	.65032	.65032	.65032	.65032	.65032	.65032	.65032
.671482E-01	.66190	.66249	.66244	.66244	.66244	.66244	.66244	.66244	.66244	.66244
.683804E-01	.67400	.67460	.67456	.67456	.67456	.67456	.67456	.67456	.67456	.67456

Figure 31C: LSFIT Sample Output

Figure 32: LSFIT Sample Plot



Appendix 1: PMS-1D Data Acquisition Tape Description

Each record on the PMS-1D data acquisition tape contains four seconds of data. Each second has data for four probes. These probes are subdivided into sixteen 24 bit words. The 24 bit words are composed of four 6 bit characters (four bit BCD plus 2 fill bits).

The record size (in bits) is then:

$$4 \frac{\text{seconds}}{\text{record}} \times 4 \frac{\text{probes}}{\text{seconds}} \times 16 \frac{\text{words}}{\text{probe}} \times 24 \frac{\text{bits}}{\text{word}} = 6144 \frac{\text{bits}}{\text{record}}$$

In CDC 660 words this becomes

$$6144 \frac{\text{bits}}{\text{record}} \times \frac{1 \text{ word}}{60 \text{ bits}} = 102.4 \text{ words}$$

This input record format is illustrated in Appendix 2.

The first of the four probes contains VCO information. This includes the PMS elapsed second counter, the real time clock values, and the voltage levels for each of the VCO devices. The remaining three probes (SCATTER,CLOUD and PRECIP) each have a hosekeeping word as its first element. The number of particles counted in size channels 1-15 of each device are words 2-16. The structure of these four probes is shown in Appendix 3.

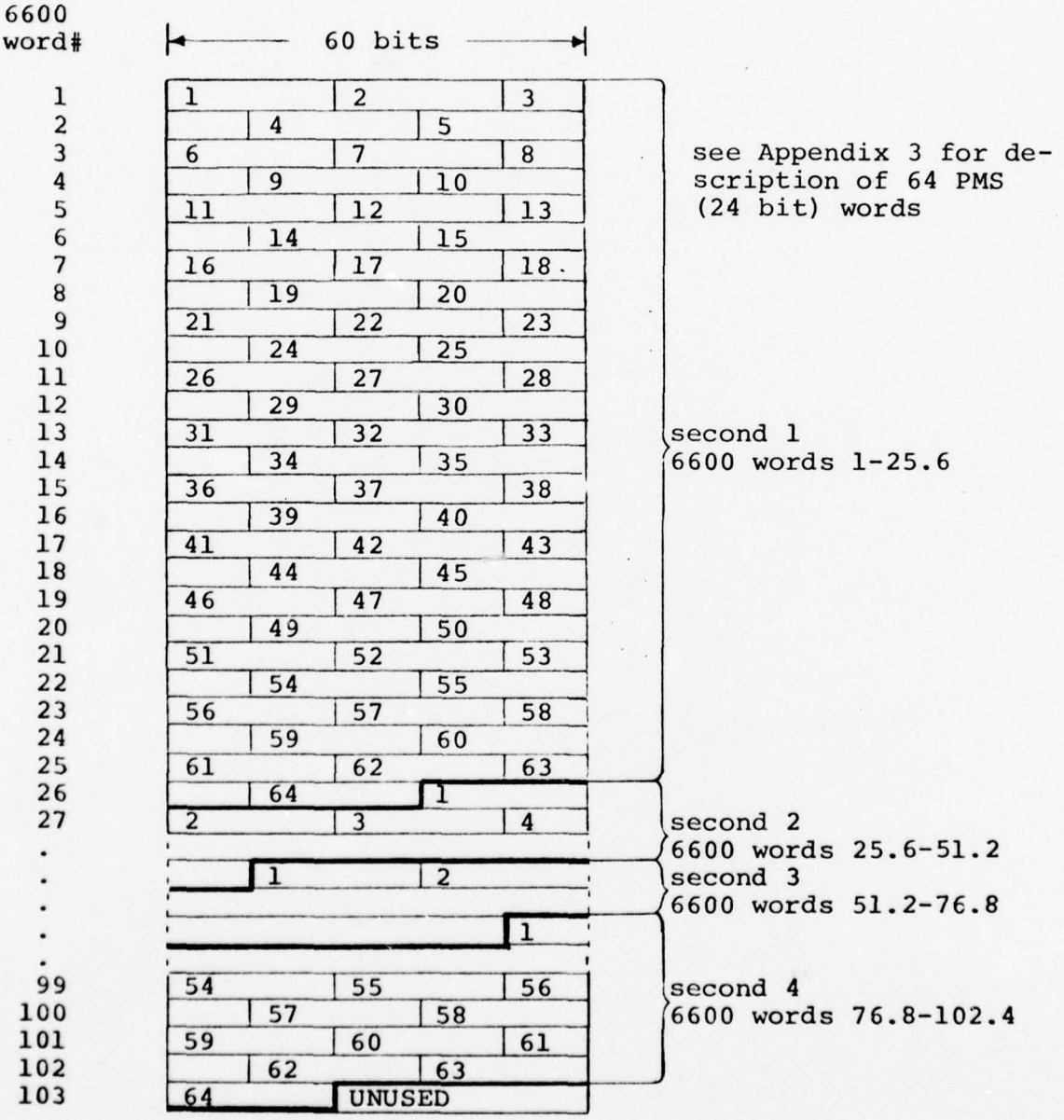
The housekeeping word on the probes (excepting the VCO) is a voltage/temp indicator to monitor key points of the particular device. As a means of monitoring ten different

Appendix 1: PMS-1D Data Acquisition Tape Description (cont'd)

parameters with the same word, the units of the elapsed second clock determines which housekeeping parameter is being recorded. Appendix 4 lists the elapsed second digit and the corresponding housekeeping reading for each probe.

Appendix 2: C130 PMS-1D Data Acquisition Tape Format

Record length:	1024 characters
Character length:	4 bit BCD + 2 leading bits
Buffer size:	103 60 bit words or 256 24 bit words
Time:	4 seconds/record 64 24 bit words/second
Parity:	odd
Density:	556 bits per inch



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
elapsed time	IAS	TEMP	EWER	N/A	DEWP	LWC-JW	HEAD-ING	PRES-SURE	TAS	UNUSED				min, sec	hrs

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
scatter	status *	ch 1	ch 2	ch 3	ch 4	ch 5	ch 6	ch 7	ch 8	ch 9	ch 10	ch 11	ch 12	ch 13	ch 14	ch 15

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
cloud	status *	ch 1	ch 2	ch 3	ch 4	ch 5	ch 6	ch 7	ch 8	ch 9	ch 10	ch 11	ch 12	ch 13	ch 14	ch 15

	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
precip	status *	ch 1	ch 2	ch 3	ch 4	ch 5	ch 6	ch 7	ch 8	ch 9	ch 10	ch 11	ch 12	ch 13	ch 14	ch 15

* See Appendix 4 for expansion of status words

ending digit of second	scatter probe status	#	cloud probe status	#	precip probe status	#
0	+15v. supply voltage	1	+15v. supply voltage	2	+15v. supply voltage	3
1	probe temp	4	mirror temp	5	mirror temp	6
2	size range selected	7	element 1 voltage	8	element 1 voltage	9
3	laser reference voltage	10	element 24 voltage	11	element 24 voltage	12
4	-15v. supply voltage	13	-15v. supply voltage	14	-15v. supply voltage	15
5	electronics temp	16	+5v. supply temp	17	+5v. supply temp	18
6	+5v. supply voltage	19	+5v. supply voltage	20	+5v. supply voltage	21
7	+5v. supply temp	22	electronics temp	23	electronics temp	24
8	+15v. supply voltage	25	+15v. supply voltage	26	+15v. supply voltage	27
9	probe temp	28	mirror temp	29	mirror temp	30

Appendix 5: KNOLL1D TAPE2 Format

RECORD LENGTH: 130 words (60 bit)
TIME: 1 rec/interval ave data
1 rec/second full data
PARITY: odd
DENSITY: variable

WORD(S)	VARIABLE	DESCRIPTION	
1	TAIR	A/C TIME (HH:MM:SS)	
2	TPMS	PMS TIME (HH:MM:SS)	at interval start of ave data
3	ESEC	PMS COUNTS	
4	ITYPE	PARTICLE TYPE	
5	INTA	AVERAGING INTERVAL	
6	IFORM	OUTPUT OPTION	
7	INTRP	INTERPOLATION	
8	FLIGHT ID	FLT E78-01	
9	FLIGHT DATE	DD MON YR (@12@MAR@78)	@ = blank
10-24	DEN(1-15,1)	DENSITY (SCATTER)	
25-39	DEN(1-15,2)	DENSITY (CLOUD)	
40-54	DEN(1-15,3)	DENSITY (PRECIP)	
55-67	VCO (13)	VCO's	
68-71	LWC (4)	LWC (Sc,Cl,Pr,Total)	see Appendix 6 for details
72-75	Z (4)	Z (Sc,Cl,Pr,Total)	
76-79	D0 (4)	MEDIAN VOLUME DIAMETER (Sc,Cl,Pr,Total)	
80-83	K (4)	$K = M/(Z)^{1/2}$ (Sc,Cl,Pr,Total)	
84	FF	FORM FACTOR	
85	SFACT	STABILITY FACTOR	
86-130	CTR (3,15)	EQUIVALENT MELTED DIAMTERS	

Appendix 6: KNOLL1D TAPE2 VCO Placement

WORD	KNPLT1D AXIS CODE	NAME
55	1	PRESSURE
56	2	EWER
57	3	HEIGHT
58	4	TEMPERATURE
59	5	DEWPOINT
60	6	LWC-JW
61	7	IND AIRSPEED
62	8	Δ PRESSURE
63	9	UNUSED
64	10	HEADING
65	11	CALCULATED AIRSPEED
66	12	TRUE AIRSPEED
67	13	UNUSED
68	14	LWC SCATTER
69	15	LWC CLOUD
70	16	LWC PRECIP
71	17	LWC TOTAL
72	18	Z SCATTER
73	19	Z CLOUD
74	20	Z PRECIP
75	21	Z TOTAL

Appendix 7: KNOLL1D TAPE3 Format

TAPE 3

RECORD LENGTH: 12 word (60 bit)

TIME: 1 rec/interval

PARITY: even (formatted)

DENSITY: variable

FORMAT (1X,A10,1X, 4(1PE10.3), 1X,4(1PE10.3),1X, 4(1PE10.3))

WORD(S)	VARIABLE	FORMAT	DESCRIPTION
1	ITIM	A10	CLOCK
2-5	LWC (4)	1PE10.3	LWC (Sc,Cl,Pr,Total)
6-9	Z (4)	1PE10.3	Z (Sc,Cl,Pr,Total)
10-13	D0 (4)	1PE10.3	D0 (Sc,Cl,Pr,Total)

Appendix 8: KNOLL1D TAPE4 Format

TAPE 4 (PUNCH FILE)

RECORD LENGTH: 8 words (60 bit)

TIME: 1 rec/interval

PARITY: even (formatted)

FORMAT (1X,3A2,1H.,5X,F7.1,5X,4(1PE10.3))

WORD(S)	VARIABLE	COLUMNS	DESCRIPTION
1	IH	2-3	Hours
2	IM	4-5	Minutes
3	IS	6-7	Seconds
4	HTFT	14-20	Height(feet)
5-6	LWC(2)	16-35,36-45	LWC(PR,Total)
7-8	Z(2)	46-55,56-65	Z(PR,Total)

Appendix 9: KNOLL1D TAPE7 Format

TAPE 7 (RAPP TAPE)

RECORD LENGTH:	9 words (60 bit)
TIME:	1 rec/averaging interval
PARITY:	odd
DENSITY:	variable

WORD	PARAMETER
1	DATE (731222.) = 22 DEC 73
2	TIME (24157.) = 02:41:57
3	averaging interval (seconds)
4	Water Content (gm/m^3)(Scatter Probe)
5	Water Content (gm/m^3)(Cloud Probe)
6	Water Content (gm/m^3)(Precip Probe)
7	Radar Reflectivity (mm^6/m^3)(Scatter Probe)
8	Radar Reflectivity (mm^6/m^3)(Cloud Probe)
9	Radar Reflectivity (mm^6/m^3)(Precip Probe)

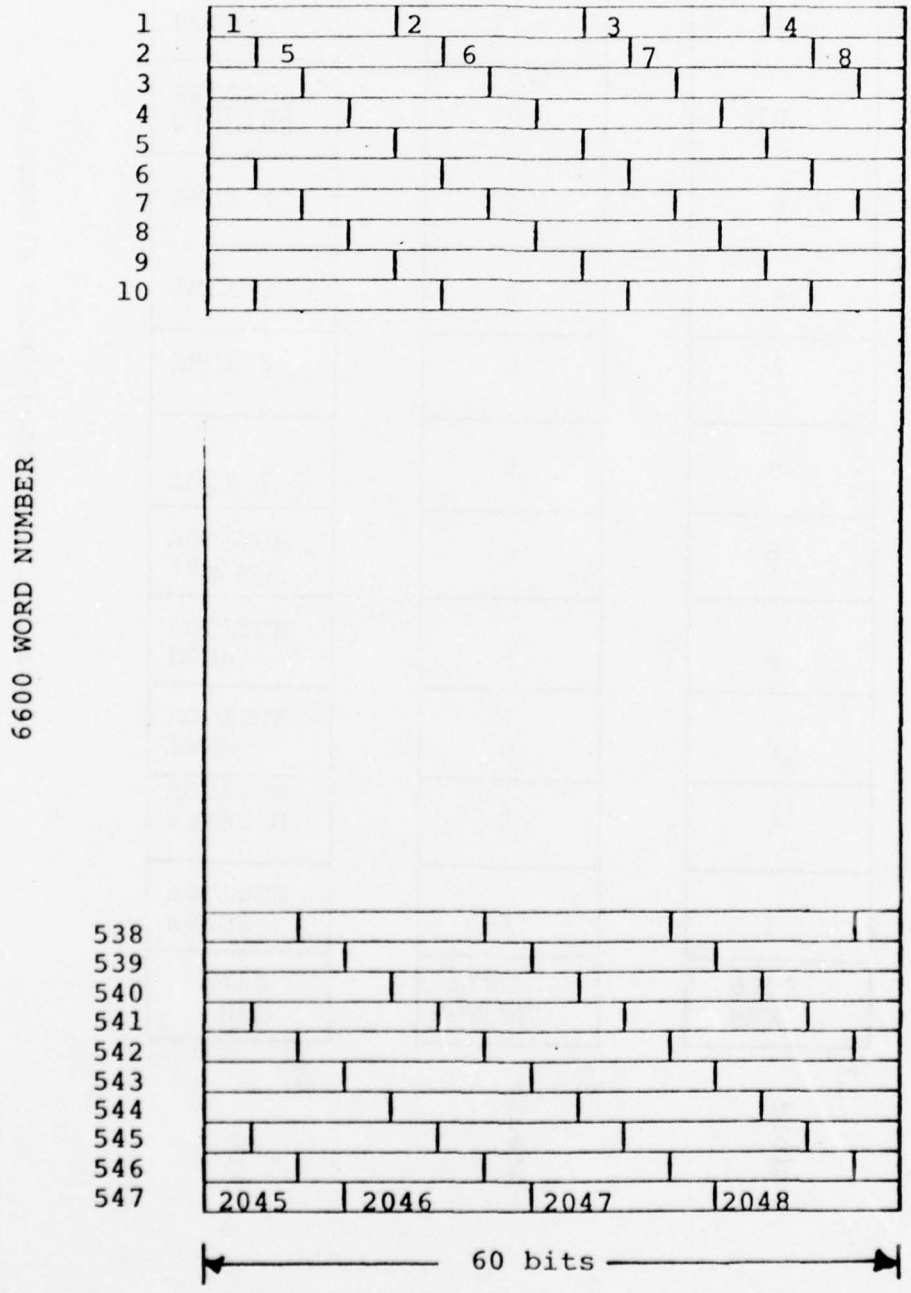
Appendix 10: LEAR 210 Word Processed Tape

RECORD LENGTH: 210 words (60 bit)
TIME: 1 record/second
PARITY: odd
DENSITY: variable

WORD	PARAMETER
1	FLAG fixed to 7777.
2	DATE (731222.) = 22 DEC 73
3	TIME (24157.) = 02:41:57
4	SEC fixed to 1.
5	TAS (m/sec)
6	PRES(mb)
7	ALT(km)
8	TEMP (C)
9	Water content (gm/m^3)(Scatter Probe)
10	Water content (gm/m^3)(Cloud Probe)
11	Water content (gm/m^3)(Precip Probe)
12	Radar reflectivity (mm^6/m^3)(Scatter Probe)
13	Radar reflectivity (mm^6/m^3)(Cloud Probe)
14	Radar reflectivity (mm^6/m^3)(Precip Probe)
15	Total counts (Scatter Probe)
16	Total counts (Cloud Probe
17	Total counts (Precip Probe)
18	TWCI water content
19	TWCI freq1
20	Dewpoint (°C)
21	No. Density (SZD/m)(Scatter Probe)
22	No. Density (SZD/m)(Cloud Probe
23	No. Density (SZD/m)(Precip Probe)
24	TWCI freq2
25	TWCI temp1
26	TWCI temp2
27	largest particle size
28	average particle size
29	JW-LWC
30	particle type code
31-75	counts for size channels 1-45
76-120	unormalized Number Density for size classes 1-45 (SZD/m^3)
121-165	water content for size channels 1-45 (gm/m^3)
166-210	equivalent melted diamter for size channels 1-45 (u)

Appendix 11: LEAR PMS-1D Data Acquisition Tape Format

RECORD LENGTH:	8192 CHARACTERS
CHARACTER LENGTH:	4 BITS BCD
BUFFER SIZE:	547 60 BIT WORDS OR 2048 16 BIT WORDS
TIME:	32 SECONDS/RECORD 64 16 BIT WORDS/SECOND
PARITY:	ODD
DENSITY:	800 BPI (9 TRACK)



	Start																	End
scatter	0	FORMVAR FOOTAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
cloud	17	HEX 9333	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	32
precip	33	ELAPSED TIME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	48
VCO	49	HEX 8192	PRESS VOLTAGE	PRESS G VOLTAGE	TEMP VOLTAGE	DEWP VOLTAGE	JW-LWC VOLTAGE	TWCI 1	TWCI 2	TWCI 3	TWCI 4	MINUTES / SECONDS	HOURS	UNUSED	UNUSED	UNUSED	UNUSED	64

Appendix 12: PMS-1D Word Allocation

Appendix 13: PMS-2D Particle Image Tape Description

Data collected by the cloud and precip PMS-2D data acquisition devices are written to tape by a PERTEC recorder. The data collected by either device is double-buffered to minimize loss of data.

There are two kinds of records written to this tape, slow and fast.

Slow data records are 86 CDC 6600 words long and contain the real time clock value and VCO readings for each second. One slow record is written every ten seconds and thus contains ten seconds worth of data.

Fast data are the records produced by the PMS-2D buffers, and are 547 60 bit words in length. These records contain the results of 1024 scans of the 32 diodes. Each scan is a binary representation of each diodes state. If when scanned a diode was on a zero is recorded, if off a one is recorded. In order to minimize data written all blank scans are counted and when the next particle is detected, the number of blank scans is written onto the tape. This counter is prefaced by a bit pattern of 10101010 to differentiate it from a regular diode scan. The first scan has the elapsed second counter, overload status and a probe indicator. If one buffer is being written to tape and the other buffer for this probe is also filled the probe is said to be overloaded.

Appendix 14: C130/LEAR PMS-2D Fast-Data Record Format

RECORD LENGTH: 1025 32 bit scans
547 60 bit words
SCAN RATE: 1 every 250 nano-seconds maximum

6600 WORD#

1	time & id word *	scan 1
2	scan 2	scan 3
3	scan 4	scan 5
4	scan 6	scan 7
5	scan 8	scan 9
6	scan 10	
7	scan 11	scan 12
8	scan 13	scan 14
9	scan 15	scan 16
10	scan 17	scan 18
539	scan 1009	scan 1010
540	scan 1011	scan 1012
541	scan 1013	
542	scan 1014	scan 1015
543	scan 1016	scan 1017
544	scan 1018	scan 1019
545	scan 1020	scan 1021
546	scan 1022	scan 1023
547	scan 1024	

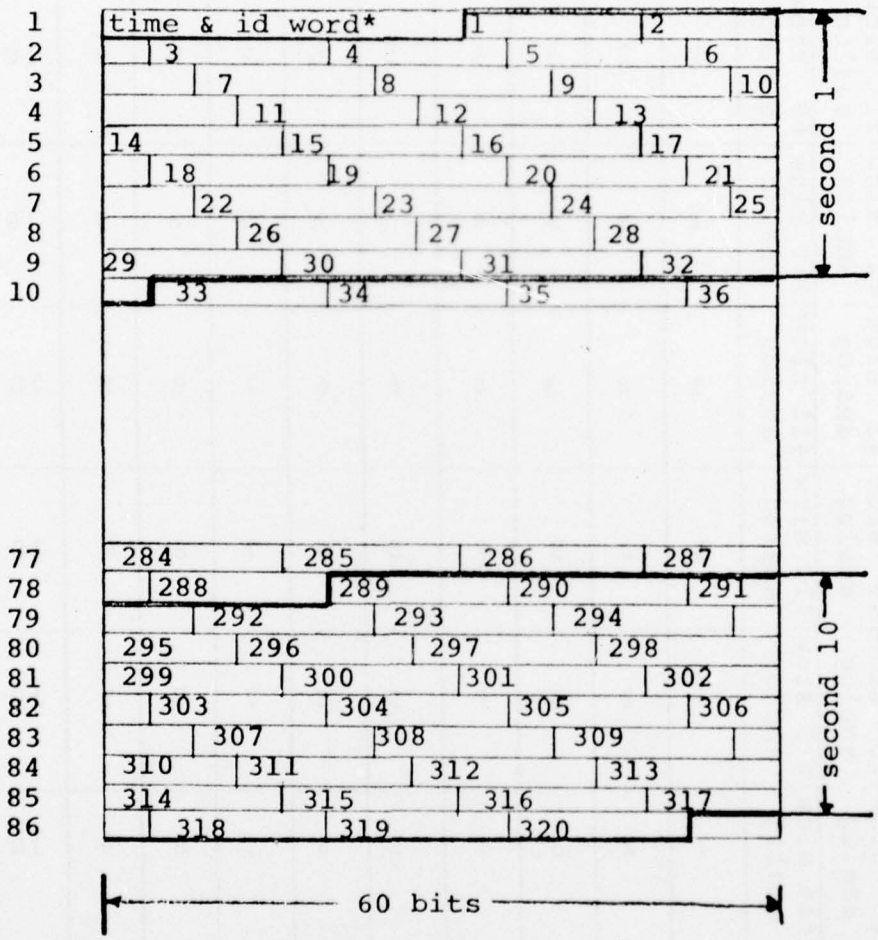
60 bits

* see appendix 17 for time and id word description

Appendix 15: C130/LEAR PMS-2D Slow-Data Record Format

RECORD LENGTH: 322 16 bit words
86 60 bit words
RECORD TIMING: 1 every 10 seconds

6600 WORD#

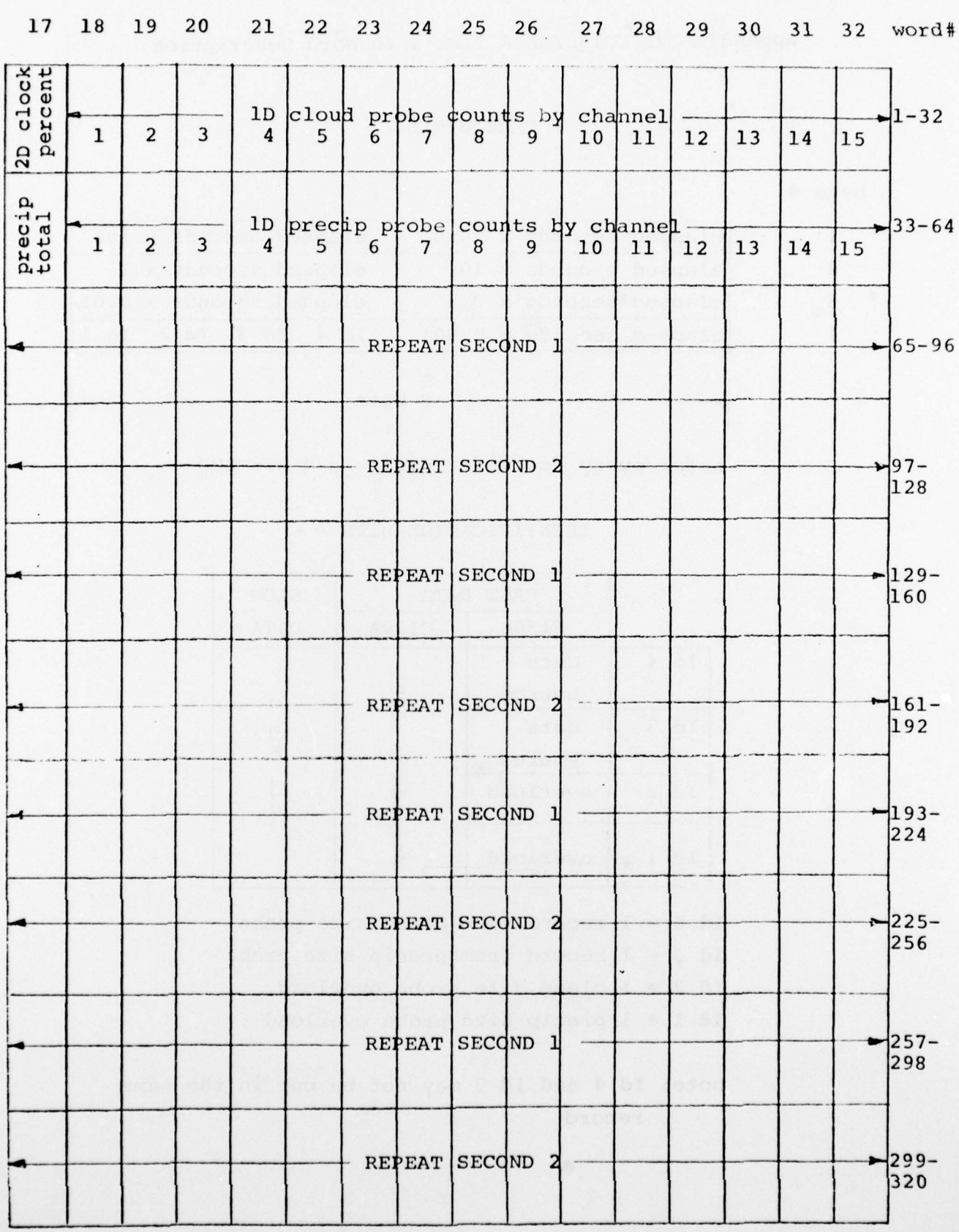


* see appendix 16 for time and id word description

Appendix 16: C130 PMS-2D Slow Data Record Allocation

sec.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	unused / sec·10k	elapsed seconds	32 bits parallel	digital input	← VCO channels → 1	2	3	4	5	6	7	8	9	10	11	12
2	cloud status#1	precip status#1	cloud total 2D	precip total 2D	1	2	3	4	5	6	7	8	9	10	11	12
3	cloud status#2	precip status#2	#1 slow analog	#9 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
4	cloud status#3	precip status#3	#2 slow analog	#10 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
5	cloud status#4	precip status#4	#3 slow analog	#11 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
6	cloud status#5	precip status#5	#4 slow analog	#12 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
7	cloud status#6	precip status#6	#5 slow analog	#13 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
8	cloud status#7	precip status#7	#6 slow analog	#14 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
9	cloud status#8	precip status#8	#7 slow analog	#15 slow analog	1	2	3	4	5	6	7	8	9	10	11	12
10	cloud status#9	precip status#9	#8 slow analog	#16 slow analog	1	2	3	4	5	6	7	8	9	10	11	12

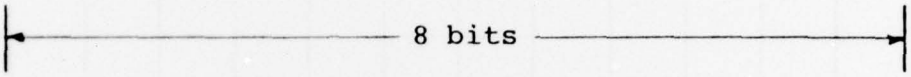
Appendix 16: C130 PMS-2D Slow Data Record Word Allocation



Appendix 17: C130/LEAR Time & ID Word Description

TIME BYTES

byte #		
1	elapsed seconds x 1000	elapsed seconds x 100
2	elapsed seconds x 10	elapsed seconds x 1
3	elapsed seconds x 0.1	elapsed seconds x 0.01
4	elapsed seconds x 0.001	Id 4 Id 3 Id 2 Id 1



note: every "seconds" digit is 4 bit BCD

IDENTIFICATION BITS

	FAST DATA		SLOW DATA
	C130E	C130A	
Id 4	data source	seconds x .0001	all one's
Id 3	data source		
Id 2	overload		
Id 1	overload		

Id 4 = 1, record from cloud size probe
Id 3 = 1, record from precip size probe
Id 2 = 1, cloud size probe overload
Id 1 = 1, precip size probe overload

note: Id 4 and Id 3 may not be one in the same record

Appendix 18: PMS-2D Particle Tape Format

RECORD FORMAT: SCOPE-NOS/BE
RECORD LENGTH: VARIABLE MINIMUM 12 WORDS, MAXIMUM 512
RECORD TYPE: BINARY

WORD	DESCRIPTION
1	TIME OF RECORD IN FORM HH:MM:SS.F (DISPLAY CODE)
2	SLOW RECORD AND FAST RECORD NUMBER IN FORM WORD 2 = SLOW*10000 + FAST (BINARY)
3	SAMPLE TIME IN MS (BINARY)
4	CLOCK SAMPLING RATE-PERCENTAGE (BINARY)
5	PROBE (BINARY)
6	OVERLOAD INDICATOR (BINARY)
7	KISTLER AND BACKUP PRESSURE IN FORM WORD 7 = KIST*10000 + PRESS (BINARY-VCO COUNTS)
8	PRESSURE GRADIENT VCO COUNTS (BINARY-VCO COUNTS)
9	TEMPERATURE VCO COUNTS (")
10	DEWPOINT VCO COUNTS (")
11	TRUE AIRSPEED (")
12	JW-LWC VCO COUNTS (")
13	AREA IN SQUARE DIODES-NEGATIVE IF EDGE REJECTION (BINARY)
14	PERIMETER IN DIODES (")
15	HORIZONTAL FERET PROJECTION IN DIODES (BINARY)
16	VERTICAL FERET PROJECTION IN DIODES (")
17	HORIZONTAL PROJECTIONS IN DIODES (")
18	VERTICAL PROJECTIONS IN DIODES (")
19	UNUSED
20	MAXIMUM LENGTH IN DIODES (")
21	THETA ANGLE OF PARTICLE ORIENTATION (")
22	VOLUME IN CUBIC DIODES (")
.	
.	
.	
512	VOLUME IN CUBIC DIODES

Each record consists of the 12 word identification block and then up to 50 particle descriptions, each 10 words long. One fast input record to TWODEE can generate one or more of these records. The length of each output record is determined by the number of particles in each fast input record.

Appendix 19: SPANDAR Input Tape Format

TAPE1 (SPANDAR)
PARITY: EVEN
DENSITY: 800 BPI (7 TRACK)
RECORD: VARIABLE LENGTH
TIME: 1 SECOND PER DATA RECORD

The SPANDAR input tape consists of multiple sets of:
1 header record followed by many data records

HEADER RECORD (28 bytes)

BYTES	TYPE	DESCRIPTION
6	8 bit EBCDIC	A/C type (6 char)
2	fixed binary	Run ID Number (pass)
2	"	Day of Scan (DOY)
2	"	Year of Scan (2 digits)
2	"	Scan Number
2	"	Time of Scan (hours)
2	"	Time of Scan (minutes
2	"	Number of data records
4	floating point	Time of Scan (seconds)
4	"	Nominal Altitude (feet)

DATA RECORDS one per second (40 bytes)

2	fixed binary	Greenwich Time (hours)
2	"	Greenwich Time (minutes)
4	floating binary	Greenwich Time (seconds)
4	"	Average Reflectivity (dbz)
4	"	Elevation (degrees)
4	"	Azimuth (degrees)
4	"	Radar Slant Range (nm)
4	"	Ground Range (nm)
4	"	Ground Range (nm)
4	"	Altitude (feet)
4	"	Altitude (km)

Appendix 20: SPANDAR TAPE3 Format

TAPE3

TYPE: SCOPE-NOS/BE STANDARD
RECORD: VARIABLE LENGTH
TIME: 1 SECOND PER DATA RECORD

HEADER RECORD LENGTH 2 WORDS

WORD 1 ZERO OR DAY OF YEAR
WORD 2 FOR SPANDAR TAPE

DATA RECORD LENGTH 7 WORDS (DISPLAY CODE)

SPANDAR output tape consists of multiple sets of header record followed by a variable number of data records

FORMAT	DESCRIPTION
2X	blank
I3	GMT (hours)
I3	GMT (minutes)
F7.3	GMT (seconds)
F9.0	radar slant range (meters)
F8.3	azimuth (degrees)
F7.3	elevation (dgrees)
F9.0	altitude (meters)
F7.1	reflectivity (dbz)
F6.0	counts (forced to zero)

Appendix 21: SPANDAR TAPE4 (Punch File) Format

The SPANDAR output deck consists of multiple sets of: 1 header card followed by many data cards.

HEADER CARD

COLUMNS	DESCRIPTION
1	1
4-13	Date
16-21	Aircraft
24-26	Pass No.
29-36	Altitude (feet)
39-41	Scan No.
44-46	No. of Data cards that follow
49-56	Start Time (hhmmss.f)
59-66	Stop Time (hhmmss.f)

DATA CARDS

COLUMNS	DESCRIPTION
1	Blank
2-9	Time (hhmmss.f)
10-14	Blank
15-22	Z (DBZ)
23-30	Elevation (deg)
31-38	Azimuth (deg)
39-46	Radar Slant Range (NM)
47-54	Ground Range (NM)
55-62	Ground Range (NM)
63-70	Altitude (feet)
71-78	Altitude (km)

Appendix 22: MORT Input Tape Format

HEADER RECORD

5A6	Title
E15.7	RCS o-count equivalent (dBsm)
E15.7	RCS count increment equivalent (dBsm)
A6	Radar sensor used

DATA RECORD

2I3,F7.3	Time (Hours, minutes, seconds)
F9.0	Range (meters)
F8.3	Azimuth (degrees)
F7.3	Elevation (degrees)
F9.0	Altitude (degrees)
F7.1	Z ($dB\text{-}mm^6/m^3$)
F6.1	RCS counts
F8.3	M (gm/m^3)
F6.1	Polarization Ratio (PP to OP in dB)
F6.1	Average S/N (dB)
F6.1	Average cross section (dBsm) = .55118·counts - 170
I5	Total number of data points available in averaging interval
I5	Number of points accepted for use

Appendix 23: RAPP Radar Tape Format

VARIABLE	DESCRIPTION
HR:MN:SC.F	HOURS, MINUTES AND DECIMAL SECONDS
Z(DBZ)	RADAR READING
EL (DEG)	ELEVATION OF RADAR DEGREES
ZA (DEG)	AZIMUTH OF RADAR DEGREES
RSLRA(NAM)	SLANT RANGE NAUTICAL MILES
GRRA(NM)	GROUND RANGE NAUTICAL MILES
GRRA(KM)	GROUND RANGE KILOMETERS
ALT(FT)	ALTITUDE IN FEET
ALT(KM)	ALTITUDE IN KILOMETERS

VCO CHANNEL	SYMBOL	DESCRIPTION	CALIBRATION INTERCEPT	SLOPE	3RD TERM	UNITS
1	IAS	Indicated Airspeed (a/c Pitot static)	- 616.89110	+0.177903	-0.9193E-5	knots
2	TEMP	Total Temperature (Rosemount)	- 50.8911	+0.0009721	+3.08027E-8	°C
3	B-PRES	Air Pressure (backup)	-5920.416	+0.806546	0.0	mb
4		unused	-	-	-	-
5	DEWP	Dewpoint (Cambridge 1011)	- 47.61492	+0.009691	0.0	°C
6	LWC-JW	Liquid Water Content (Johnson Williams)	- 2.9286	+5.952E-4	0.0	gm/M^3
7	MHEAD	Magnetic Heading (a/c Compass)	+ 179.0874	-0.035818	0.0	°N
8	K-PRES	Air Pressure (Kistler)	+1135.464	-0.0099879	0.0	mb
9	TAS	True Airspeed	- 50.0	+0.05	0.0	m/sec
10	EWER	Liquid Water Content (Aerospace)	0.0	+1.0	0.0	counts
11	-	unused	-	-	-	-
12	-	unused	-	-	-	-

Appendix 24: C130E VCO's (PMS-1D system)

VCO CHANNEL	SYMBOL	DESCRIPTION	CALIBRATION	UNITS
1	PRES	Air Pressure (Validyne)	$Y=(2.102646E-3)X^{1.04065}$	mb
2	Δ-PRES	Differential Pressure (Validyne)	$Y=(1.3312E-2)X^{0.8631}$	mb
3	TEMP	Total Temperature (Rosemount)	$Y=(0.02359)X-69.31$	°C
4	DEWP	Dewpoint (EG & G)	$Y=(0.0201)X-51.03$	°C
5	LWC-JW	Liquid Water Content (Johnson-Williams)	$Y=(1.0)X$	counts
6	-	unused		
7	TWCI	Reference Frequency	n/a	
8	TWCI	Sense Frequency	n/a	
9	-	unused		
10-11	HMS	BCD Clock	n/a	
12	-	unused		
13	TWCI	Zero Set Mode	n/a	
14	TWCI	Reference Temperature	n/a	
15	TWCI	Sense Temperature	n/a	

Appendix 25: LEAR VCO's (PMS-1D system)

Appendix 26: RTX/8 TU-10 Tape Format